THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 60 Thursday, April 6, 1939 No. 1181

PUBLISHED WEEKLY

Subscription Terms : 17s. 6d. per annum.
Foreign and Colonial : 20s. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address : "Zacatecas, Rand, London."
Telephone : Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1938-39

J. Hepworth, J.P., M.P., "Ingle Nook," Bolton Road, Bradford.

LIST OF SECRETARIES—

General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office : 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.
East Midlands : B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.
Lancashire : J. E. Cooke, 7, Warren Drive, Swinton, Manchester.
London : G. W. Daglish, Stewarts & Lloyds, Limited, Winchester House, Old Broad Street, E.C.2
Middlesbrough : G. P. Kirk, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.
Newcastle-upon-Tyne : C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
Scottish : J. Bell, 60, St. Enoch Square, Glasgow.
Sheffield : T. R. Walker, M.A., F.I.C., 11, Broomgrove Crescent, Sheffield, 10.
Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport, Mon.
West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
South Africa : F. C. Williams, Magor House (Fifth Floor), 74, Fox Street, Johannesburg.

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.
Burnley : W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.
East Anglian : J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.
Falkirk : T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.
Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President : Sir Harold Hartley, F.R.S., Euston Station, London, W.C.1.
Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary : Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President : G. E. France, August's, Limited, Thorn Tree Works, Halifax.
Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President : W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Colmore 4274-4275 *Telegrams : CIRA*
The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE
The National Physical Laboratory	281
Moulding Test-Bars	281
Correspondence	282
Elasticity of Cast Iron	282
Catalogues Received	282, 289
Notes from the Branches	282
A Commemorative Medal	282
Foundry Work in Dentistry	283
New Items in Income-Tax Assessment	284
Molybdenum in Cast Iron	285
Foundry Time Studies	286
Nickel in the Non-Ferrous Foundry	287
Vitreous Enamelling Section—	
Some Impressions of American Enamelling Practice	290
Further Observations on Scientific Aids to Control in Vitreous Enamelling	292
Books on Enamelling	292
Technical Problems in Vitreous Enamelling	293
Thermal Insulating Material	296
Company Meetings	296
The Week's News in Brief	298
Raw Material Markets	300

The National Physical Laboratory

Specialists are all apt to regard the National Physical Laboratory from their own angle, and the viewpoint assumed by the average foundryman is that it is an organisation for the production of fundamental scientific data which are later used by industry. Its function is much broader than that, and there is an objectivity behind all its work, which may or may not be sponsored by some section of industry. The development of modern civilisation has introduced the curse of noise, which reacts in varying degree upon the nerves of everybody. At the moment, the minimisation of noise is engaging the attention of a large number of members of the scientific staff. An outstanding advantage which the Laboratory possesses, and very wisely uses, is its close association with the work carried out by the various research associations. From these contacts they learn of methods of approach used by an Association catering for a specialised industry which they can apply, if it be deemed suitable, to entirely different industries. Whilst the laboratory is universally appreciated as an originator of new knowledge, yet as a clearing house for scientific developments its worth is also recognised. The foundry industry is interested in the activities of most of the departments. To the Metrology Department it owes the accuracy of jigs, tools and gauges. The Engineering Department has contributed indirectly to the esteem in which cast components subjected to dynamic stresses are to-day held by engineers and designers. The Metallurgy Department each year contributes fundamental knowledge of the properties of alloys currently used in foundry practice. Indeed, "Y" alloy was discovered at Teddington. There has not been, according to the Report* for the year 1938, a great quantity of investigational work undertaken of direct interest to manufacturers of iron castings, but for those making light alloys the investigations of aluminium and magnesium alloys, especially in relation to intercrystalline cracking, register useful progress.

It is interesting to learn that the confidence which industry has always placed upon Seger cones has been well justified, and "it has been found that the cones, when properly used, allow the measurement of temperature over this range [1,560 to 1,760 deg. C.] with a precision which is little inferior to that of a good optical pyrometer." Work which is very much appreciated in foundry circles is that which is being undertaken for the purpose of establishing the accurate estimation of oxygen, nitrogen and hydrogen in steel, for doubtlessly, once methods are established, they will be applicable, with perhaps minor alterations, to ferrous casting alloys. The next phase, that of the influence of the various gases on the physical properties of steel and iron, will be of exceptional interest.

* Published by H.M. Stationery Office, York House, Kingsway, London, W.C.2. (Price 2s. 6d. net.)

Moulding Test-Bars

The old 2 in. by 1 in. cast-iron transverse test-bar broken between 3-ft. centres may not be representative of the casting, but it had one advantage the new round bars do not as yet possess, inasmuch as it ensured more or less a standardised method of making test-bars. With the old bar it was customary to cast in the horizontal position, or on the slope, running it from one end and very often placing a riser at the other. The design of the bar in fact prevented it being readily cast in any other position. Providing due care was taken to place the bar in the testing machine the same way each time, *i.e.*, with the top side as cast under compression, little trouble arose through variation in test results due to moulding methods.

It is obvious, however, that the new round bars can be made in a variety of totally different ways, and this is liable to cause considerable variation in the final test figures obtained. Furthermore, it is possible that certain methods of test-bar manufacture should be avoided as they are known to give erratic and low results. This could be largely overcome if the principal specifications concerned contained, possibly in the form of an appendix, some indication of the most suitable moulding methods which should be adopted. Similar remarks apply to non-ferrous foundries in connection with the manufacture of gunmetal and bronze tensile test-bars, and in this latter direction it is interesting to note that in the United States the Federal Government include an outline of suitable test-bar moulding methods in their specifications.

It would be useful if this question could be considered in the first instance by both the Cast Iron and Non-Ferrous Sub-Committees of the Technical Committee of the Institute of British Foundrymen with the view of seeing what could be done in the matter. Certainly, if some indication along the lines suggested could be arrived at, it would not only be a valuable asset for the smaller foundries but would enable more comparative test results to be obtained from the industry as a whole.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

A New Steelmaking Process

To the Editor of The Foundry Trade Journal.

Sir,—I refer to the article on "A New Steelmaking Process" which you contributed to the issue of March 23. Whilst agreeing that the L.M.S. Railway Company have made an excellent application of the Sesci furnaces to their steel requirements, I should like to correct one or two statements made by you, as they are far too casual regarding the pioneer work done by my company in this regard.

At the outset, you state that you believe the first large-scale attempt to manufacture steel in the rotary furnace fired by pulverised fuel took place at the Mons Steel Foundry in Belgium. Here, you are definitely incorrect, as the first steel made in this manner was made at Gateshead. Mr. Deschamps, of Kryn & Lahy, was present on that occasion, and the date was in 1932—some considerable time before Mons installed this type of plant.

In your second paragraph you refer casually to my firm having made from time to time heats of steel in this manner. Let me assure you that a definite business of steel-casting manufacture was built up from that date in 1932; so much so that it has been necessary to add a 15-ton melting furnace to augment the demand for steel castings. It was in December, 1932, that I personally gave a lecture on steelmaking by this process before the Glasgow Branch of the Institute of British Foundrymen. This proves that the process is not exactly a new steelmaking process. The technique of fettling the hearth as detailed by you was also used by us five years ago, and is still in use to-day.

The possibilities of a basic lining were also realised, and some three years ago a complete basic lining was installed. This proved a failure at that time, not due to the expansion of this refractory, but to the loss of heat absorbed in the lining itself. It is well known that an acid lining reflects the heat from its surface far better than a basic lining, and this technical difficulty was sufficient to cut down the heat absorbed by radiation from the lining into the steel to make the lining, as installed at that time, unsatisfactory in service.—Yours, etc.,

W. Scott.

Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited.
Close Works, Gateshead-upon-Tyne.
March 29, 1939.

[There is a universal recognition of the pioneer work done by Sir W. G. Armstrong Whitworth & Company, at Close Works, under the able management of Mr. Scott on the development of rotary melting furnaces. The reference to the Mons Foundry comes about because this firm installed and used the furnace primarily for steelmaking, whereas the Close Works adapted an existing installation for the purpose of making steel. Thanks are due to Mr. Scott for his interesting contribution on the subject of basic linings.—Editor.]

Sand Testing

To the Editor of The Foundry Trade Journal.

Sir,—In your issue of March 2, 1939, page 196, there appears an article on "Sand Testing." In this there is given a definition of "flowability" quoted from the A.F.A. Handbook on "Testing and Grading of Foundry Sands," following which there is a description of a method for measuring this property which might lead one to believe that it is a standard A.F.A. method.

Permit me to say that the A.F.A. has not, up to the present time, recommended any method for determining this property of sands.

Under the "Discussion" of this article it is stated that "sand testing was carried out to a greater degree in America owing to the fact that founders there had to use synthetic sands with artificial bonds more frequently than ready-made sands." This statement is hardly correct, because when the A.F.A. testing methods were introduced in 1921, and their use spread rapidly, they were applied largely to naturally-bonded sands, and they are still used for testing that type of material. They are, of course, also employed for synthetic sands.—Yours, etc.,

(*Continued in next column.*)

(*Concluded from previous column.*)

H. Ries.

Cornell University, Ithaca, New York.
March 25, 1939.

Elasticity of Cast Iron

An optical method for measuring the deflection of cast-iron transverse test-bars up to the breaking strength has been developed by A. I. Krynitsky and C. M. Saeger, Jr., of the [American] Department of Commerce, according to the "Iron Age." Deflection is determined by measuring the distance between a reference point and a rubber band mounted on the test bar, the deflection readings being independent of any movement of parts of the testing machine.

Using the above method, three types of cast irons have been investigated. The irons were heated to maximum temperatures of 1,400 deg., 1,495 deg., 1,595 deg., and 1,700 deg. C. Test-bars 1.2 in. in diameter were cast vertically, bottom poured in green-sand moulds at 82 deg., 132 deg., 182 deg., and 232 deg. C. above the liquidus temperature. Transverse properties of the test-bars were determined by interrupted loading and by direct loading up to breaking load.

From the data obtained the total, plastic, and elastic deflections, modulus of rupture, relative modulus of elasticity, total, plastic, and elastic resilience were determined for all test-bars investigated. The load-elastic deflection curves are not straight lines for their entire lengths. The relative modulus of elasticity was, therefore, determined on the straight-line portion of the curves, and also at the breaking load.

In general, the lowest and highest elastic properties were observed for the maximum heating temperatures of 1,400 deg., and 1,700 deg. C., respectively. These properties showed a tendency to decrease with an increase of pouring temperature.

The microstructure of the test-bars was examined. Comparatively fine graphite particles were discovered, which are associated with higher transverse properties. A laminated pearlite-like structure observed on some unetched specimens and the presence of large graphite particles sub-divided into hexagonal-like grains are of particular interest.

Catalogues Received

A.R.P. Material. Recent legislation adds considerable interest to a catalogue issued by Frederick Braby & Company, Limited, of 352, Euston Road, London, N.W.1. It has been compiled in four sections covering shelters; air-purification and air-circulating plants; windows, doors, shutters and emergency exits, and accessories and equipment. Each section is fully illustrated and caters for every type of application, from family use to the housing of staffs of large industrial concerns. Simplicity of construction is the key-note, with a complete avoidance of over-elaboration.

Horse-Power Calculator. The Keighley Gear Company, of Lockwood, Huddersfield, have sent us a horse-power calculator to be used in connection with worm reducers. It is made up of two rotatable discs with an indicator on the periphery and a window for obtaining corresponding readings.

Notes from the Branches

East Anglia.—The East Anglian Section of the Institute of British Foundrymen held its annual general meeting in Ipswich on March 16, Col. C. Portway presiding. Mr. J. L. Francis (hon. secretary) presented his report for the past year, and was able to report an increase in the membership of the Section, which now stands at 57. Two works visits took place, and during the session five Papers were read, one of these being by a member of the Section. The annual dinner, at which the President of the Institute was principal guest, was another successful item on the programme. Attendance at all functions had been good, the presence of visitors helping to swell the numbers. The meeting held at the Technical School at Colchester had an exceptional attendance; in this case visitors outnumbered members. More than 50 members were present at the dinner. Following the custom established at previous annual general meetings a Short Paper Competition had been organised.

The report having been adopted, the following officers were elected for the ensuing year: *President*, Mr. H. H. Shepherd; *Senior Vice-President*, Mr. G. Hall; *Junior Vice-President*, Mr. C. J. Lake; *Hon. Secretary*, Mr. J. L. Francis; *Members of Council*, Mr. A. Hammond, Mr. R. Coates and Mr. D. Guthrie. A cordial vote of thanks was accorded to the retiring President (Col. Portway).

A Commemorative Medal

Our illustration shows the medal which was struck in commemoration of the golden jubilee of the well-known Italian steelfoundry, Fonderia

Milanese di Acciaio Vanzetti. When the event was celebrated in Milan recently, in the presence of the Duke of Bergamo, each participant received one of these medals. The speech which was made by Dr. Guido Vanzetti during the ceremony has already been reported in the Journal.

Off the Target

"Marksman" misfired when referring to the early history of Mr. Thos. Cook. Here briefly are the facts. Mr. Cook was born at Melbourne, Derbyshire, on November 22, 1808, and died at Leicester, July 18, 1892. While secretary of the South Midland Temperance Association and living at Market Harborough he organised an excursion from Leicester to Loughborough for a temperance meeting. This was run on July 5, 1841, and 570 passengers travelled by it, paying 1s. a head return. It was the first excursion organised by a *private individual*. The centenary, therefore, is not next year, but in 1941.

Foundry Work in Dentistry*

By Dr. G. H. FROGGATT, M.D.S. (Sheffield), L.D.S., R.C.S. (Eng.), M.R.C.S., L.R.C.P. (Lond.)

Foundry practice in dentistry may be split into two parts. First, the materials used by a dentist in his ordinary practice, such as vulcanisers, flasks, clamps, articulators, and many other articles are made usually out of yellow brass or gunmetal. This type of work cannot be done by the ordinary practising dentist and has to be purchased from the appropriate dealers.

Materials Used

The second part can be sub-divided into two sections. The first section consists of metal models on which plates, splints, bridges and crowns may be struck or swaged. These are made from such materials as zinc, lead, babbit metal, brass and gunmetal, and fusible metal—a composition of bismuth, lead and tin melting at a temperature of roughly 90 deg. C.

In ordinary foundry practice care has to be taken to ensure that neither shrinkage nor expansion takes place in the finished casting, and for this reason special and costly patterns have to be made. It will be realised that these could not possibly be applied in the case of a metal model of the mouth. No two mouths are alike, and even though a dentist may be treating apparently identical twins, their mouths would be different, and, therefore, a model would have to be made for each.

Dentists overcome the problem of shrinkage and expansion by using a metal which will melt easily over an ordinary Fletcher Russell ladle furnace, and yet will be an exact duplicate of the pattern. It will be realised that a dental surgeon has not the same facilities as a founder; the premises he occupies may consist of a waiting room, surgery, and workshop—all rather small rooms—yet he must have facilities for casting in plaster and easily melting metals.

Modus Operandi

First he must take an impression, taking care to avoid shrinkage, and afterwards cast the model in plaster, which must be dried, the model being then used as a pattern for the finished metal casting. There is obviously a great risk of both shrinkage and expansion, and this may be overcome by coating the plaster pattern with stearine, which just allows for any slight shrinkage. Furthermore, it is advisable to cast the plaster model into the impression and obtain the metal casting the same day if possible, so that there is not time for natural shrinkage to take place.

The types of metal plates that are struck up on these finished castings are gold, platinum, dental alloy (a composition of platinum and silver), aluminium and lastly, stainless steel. The so-called stainless steel may, of course, be of the martensitic type or of the austenitic type, which is not really a steel but stainless iron. In comparing these plates, if gold is to be used it may be cast directly on to the plaster pattern, a process to which reference will be made later, or the plate may be struck up in the ordinary way. The cast plate is not quite so good as the struck-up plates. It is thicker and, therefore, heavier, and brittle.

Early Experiments with Stainless Steel

The ideal plate should be light, thin, strong and accurately fitting. Platinum, dental alloy and aluminium are not used very much to-day. Gold still holds its own, but stainless plates are rapidly supplanting the other types. The stainless material would be more commonly used if it were not so difficult to work. It is of local interest to learn that the first stainless plate was made at the Sheffield Royal Hospital before the University had a dental faculty. It was then extremely difficult to obtain suitable metals. Austenitic material was practically unobtainable, and the first plate made by the author was of the martensitic type, which is the kind used in cutlery.

It was almost impossible to obtain the sheet metal of the required gauge, namely, 28 s.w.g. Mr. Ernest Stuart, at that time a director and manager of the cutlery department of Robert Mosleys, was experimenting on the manufacture of stainless steel cutlery, and the author was very much indebted to him for the great assistance given during his early experiments. As the author did not know that the martensitic type of steel was not stainless unless it was hardened, it was most disappointing, after spending a considerable time in obtaining an accurately fitting plate, to find that it did not behave well in the mouth. Mr. Stuart had had a similar experience with cutlery. The author was told to harden the plate, which he did, but in heating up a thin plate to a temperature of 1,200 deg. C. and then plunging it into oil or water, it warped.

This difficulty was overcome by striking six plates on top, and six on the bottom, of the required plate, securely wiring them together, and heating and quenching them in order to obtain one finished accurately-fitting plate. These early plates were made from the mushroom heads of waster aeroplane valves, being rolled as near to 28 s.w.g. as possible.

Austenitic Steels

The type of steel or iron now used is of the austenitic type, which is stainless whether hard or soft, but cannot be hardened by any known process and, therefore, follows the characteristics of the non-ferrous metals. Indeed, it can only be hardened by actual working. Excellent plates are being made of this material. In order to get an accurately fitting stainless plate no fewer than six metal models must be used, as the battering necessary to strike up the plate rapidly destroys the outlines of the finished casting. The dental surgeon has no power presses and must batter his plate first of all with a horn mallet and then strike the plate between the die and counter die with a hammer—very primitive, but yet remarkable results are obtained.

The Cire Perdue Method

In the second type of casting, the impressions are taken in the usual manner and plaster poured into the impression to give a duplicate of the mouth. A thin sheet of wax is then moulded on the model of the requisite thickness for the cast plate. To this sheet of wax, wax sprues about the thickness of an ordinary hairpin are attached. [An exact pattern was exhibited, as was also a finished casting made from it.]

This is invested into a round casting ring or box. The material surrounding it is made of such materials as silica mixed with plaster and powdered asbestos or, in some cases, silica, china clay and powdered asbestos. The investment material is mixed thinly in order to flow over the wax pattern without creating air bubbles.

The actual casting may be done by (1) pressure, (2) vacuum or (3) centrifugally. In all cases the investment must be thoroughly heated, first of all to get rid of the wax pattern, and secondly, to ensure that the investment is sufficiently hot to enable the molten metal to run through the tiny sprue holes. The metal itself is melted in a cone-shaped depression in the investment material and, when sufficiently molten, is forced into the pattern by either compressed air or super-saturated steam.

In the author's early experiments, for small patterns he generally used a mustard tin with a lid slightly larger than the tin, into which was placed a moistened pad of asbestos or plasticine. From this was developed an old chip-potato machine, a round hollow lid being fixed to the upper and lower portions of the machine, the lower being to hold the casting ring, and the upper to retain the moistened pad of asbestos. The method was the same except that with one pull of the lever one secured a dead impact on to the top of the casting ring, thereby forcing in the molten metal. Since then most elaborate machines have been made, some of them extremely costly, but the author still retains his primitive methods, which give satisfactory results.

The vacuum machine for casting consists of a cylinder, with a vacuum pump which will exhaust the cylinder. Attached to the cylinder is a pipe carrying a ring, to which the casting ring is attached. Melting of the gold is performed by an ordinary Fletcher Russell blowpipe or similar apparatus, and as soon as the gold is melted, a tap is turned on, making a communication with the vacuum in the machine, and the gold is sucked in.

The centrifugal method consists of a casting ring with a wire loop attached. After the gold is melted, the wire loop is placed on a hook attached to a revolving handle and the casting ring is swung round. Again, this is most successful. No elaborate machines have yet been made for this method.

An Experiment in Electro-Plating

Dentistry is really a hybrid profession. The dentist must be a sculptor to a certain extent, a designer, a foundryman, a silversmith, and have a smattering of all kinds of trades. The author has at times felt himself to be on the verge of making a fortune from various inventions, but in each case it has only been a dream. For instance, he had the idea that gold could be deposited directly on to the plaster model; if teeth were standing, by filling in certain portions with wax, the model and the wax, after being coated with plumbago, could be connected to the cathode in a plating vat, first of all depositing a film of copper, and on the top of this a deposit of gold to the required thickness, blocking off in certain places to give extra thickness. Then, by taking the plate or bridge off the metal, and immersing in sulphuric acid until the copper was dissolved, beautiful plates and bridges were made. The author had never seen anything so fine, yet the result was disappointing, because he could only deposit pure gold, which is, of course, exceedingly soft, and after the patient had worn the plate for, say, three to six months, he had bitten it out of shape!

Dr. Froggatt's lecture was illustrated by the exhibition of numerous specimens.

DISCUSSION

Mr. T. R. Walker (hon. secretary), referring to the invention which Dr. Froggatt had described, inquired why the film of copper was deposited. Furthermore, the electrodeposition of chromium had reached such a stage that a very fine deposit of chromium, which was exceedingly hard, was commercially possible.

Dr. Froggatt replied that the film of copper was deposited on the plumbago-coated model for two reasons. Primarily, it was easier to deposit the gold on copper than direct on to the treated model. Secondly, and far more important in the case of a bridge which had to be cemented on to the abutment teeth in order to carry it when the copper deposit was dissolved away in sulphuric acid, it gave just sufficient clearance for a thin film of cement, thus giving perfect adhesion to the bridge which, as he had said, was cemented on to the abutment teeth.

* Abstract of a lecture given to the Sheffield Branch of the Institute of British Foundrymen, Professor J. H. Andrew presiding.

Investment Material

Mr. Roxburgh said he was very interested in the methods which Dr. Froggatt used. To him the wax impressions were wonderful. What were the materials he used surrounding the wax impressions to make the mould?

Dr. Froggatt replied that, in the case of the mould, there were no commercial products on the market and one's scope was, therefore, limited. The mould might be made from plaster of paris and sand; plaster of paris, china clay and sand; or plaster of paris, china clay, sand and powdered asbestos, the required proportions being obtained by experiment. To-day he used 48 per cent. plaster, 50 per cent. very fine silica, and 2 per cent. powdered asbestos. In the case of fine work, such as the examples he had shown, he first of all coated the pattern with a fine thin film of china clay. In the case of a flower, he always obtained the flower fresh from the tree. He made a very thin mixture of china clay and water and twirled the flower round into the mixture. He then let it partly dry and afterwards immersed it in a mixture of sand, plaster and powdered asbestos, this material being contained in the necessary casting ring.

Mr. Roxburgh asked if Dr. Froggatt ever had any trouble when he was casting. Foundrymen unfortunately got a certain percentage of wasters. Was the lecturer able to get perfect results every time?

Dr. Froggatt replied that the question of wasters depended upon the practitioner and his technique. Foundrymen in ordinary practice found out that the majority of wasters were due really to faulty technique. If they were casting by the pressure or vacuum method, they found that they must have their technique definitely satisfactory. In the first place, they had to force or suck the metal through a tiny hole, and it had to spread out over an expansive space. Also, the casting ring and mould must be almost red hot to ensure that the metal would run. When they were using pressure, it must be brought down firmly, but the gold must be molten before it was brought down. His experience of casting was that if the technique was satisfactory and one went about it in the ordinary way, all of the work would be perfect. If any mistakes were made, then only 10 per cent. of the work might be passed.

Vote of Thanks

Mr. J. E. Hurst, proposing a vote of thanks to Dr. Froggatt, said he was delighted to have the pleasure of doing so, because he thought Dr. Froggatt was present largely at his suggestion. He was sure the subject dealt with was off the beaten track so far as the Sheffield Branch was concerned. Speaking of the centrifugal casting method, Mr. Hurst said it was interesting that, with regard to the earliest of Stokes' patents for centrifugal castings which were taken out in this country, two citations were made at the British Patent Office against it. One was the very method described of centrifugal casting, an old patent dating back to before 1850; the other was a method of producing the old phonograph records, which were cast centrifugally to get the centrifugal pressure to duplicate the fine indentations on the matrix. It was a fact that the dentist's profession had nearly robbed the centrifugal casting of its early patent rights! Finally, Mr. Hurst inquired of what material artificial teeth were made.

Nature of Artificial Teeth

Dr. Froggatt replied that all types of material had been used in the manufacture of artificial teeth. Ivory examples had been found in Egyptian mummies. In the early days, the British dentist was exceedingly clever, and very fine examples of his work could be seen to-day. The teeth and palate were carved out of ivory, which was obtained from walrus tusks and in

(*Concluded on page* 300.)

New Items in Income-Tax Assessments

By F. J. Tebbutt.

With the incidence of income tax more insistent nowadays, it has been thought that a short explanation concerning assessments, under Schedule D (business profits; persons on own account) and Schedule E (employments; directorships) may be useful. Although of necessity some of the commoner phases of tax law must be referred to, the article will be confined as much as possible to the finer points of procedure with new matters (*e.g.*, A.R.P.) included in the explanation. The new forms refer to income in the year ending April 5, 1939, although under Schedule D it is permissible to substitute an earlier date according to the accounting year ending of the particular firm concerned (*e.g.*, December 31, 1938, June 30, 1938, and so forth).

General Procedure

The fundamental principle of tax law is "What is Income?" and "What is Capital?"; income is assessable, capital not assessable. Business profits are assessable, but capital (or casual) profits are not assessable; business expenses are deductible, private expenses not deductible. In the latter category come such items as drawings, dwelling house and family maintenance expenses and so forth, although if dwelling house is used partly for business purposes, a deduction can be made for rent, annual value, rates, lighting and so forth, proportionate to the part so used (up to two-thirds). The Acts do not define capital profits, but profits which are non-recurring, profits outside the ordinary business of the taxpayer, isolated transactions are usually not assessable, good examples being the sale of a house, of a business, of goodwill, of investments and so forth. Stock Exchange transactions by the individual are not usually taken into account; it must be remembered that if gains were chargeable, losses would be allowable, so such transactions are usually ignored. Premiums on leases are also ordinarily outside tax law. Profits in letting unfurnished rooms are not assessable, but it may be usefully noted as an example that where one or more rooms are let off in business premises, the rent of these need not be returned, but a proportionate deduction in the annual value (or rent) of the whole of the premises, which is deductible, must be made for the rooms so let.

Civil Defence Expenditure

With A.R.P. prominent, it is important to note that the following items of expenditure can be deducted as trading expenses: Civilian duty and service respirators, protective clothing for staff engaged on A.R.P. duties, the training of employees in such duties, covering of glass with wire netting, dark blinds, screens and paint to render windows opaque, equipment and stores for first-aid parties, equipment of decontamination squads, and emergency fittings for buildings not part of the permanent structure (*e.g.*, steel shutters for windows or timber frames and screens to provide air locks at doors and windows).

Expenditure on certain matters is, according to the circumstances ruling, sometimes deductible and sometimes not deductible. Thus, lump sums for patents, legacies, damages and the like are not assessable, but annual payments come within tax law. Subscriptions made to hospitals, welfare schemes and similar matters for the benefit of employees are deductible, although otherwise charitable donations are considered as private expenses, and are not deductible. A loss incurred in a private capacity cannot be deducted, but a loss in one business can be set against profits in another business under same ownership. Trade association subscriptions are only allowable where the body is for the advancement of the trade concerned; most bodies come under a sympathetic arrangement with the Revenue authorities allowing this expenditure. Legal costs and expenses incurred for business purposes are deductible, but not if incurred privately. Travelling expenses in connection with business are allowed, but this does not mean transport expenses to and from business. Advertisement expenses are ordinarily deductible, although a large outlay (*e.g.*, many hoardings, electric signs and so forth) may be considered as capital expenditure and disallowed.

Rent or annual value of business premises are items deductible, and as regards annual value and for ordinary businesses, this is the Schedule A assessment, meaning gross value less the statutory repairs allowances. For factories and similar premises (roughly meaning where there is machinery running) an additional deduction can be made, being either the amount of the tax repairs allowance or, if less, one-fifth of the local authority net annual value (for London and Scotland one-sixth of the gross annual value).

Wear and Tear and Obsolescence Rule

Although no sums scheduled in ordinary accounts for depreciation can be deducted, allowances can be obtained by three sets of rules in respect of machinery and plant. This term is a very wide one, and includes motor vehicles and fittings and fixtures, and also A.R.P. items of the nature of machinery and plant, such as fire appliances and air filtration plant, and the like.

By the "renewals" rule, the cost of replacements of utensils, articles of trade, etc., can go through as a trading expense; this rule is usually applied to the smaller items, the larger items coming within the wear and tear rule.

Under wear and tear procedure, a yearly percentage allowance is given off the written down value each year (*e.g.*, motor vehicles, 24 per cent.), but this must be claimed on form after profits have been declared; this claim should never be omitted, even in a year with small profits, as, if not used in any year, the balance unused can be carried forward to subsequent years indefinitely.

Then there is the obsolescence rule, which applies in respect of replacements of obsolete machinery and plant; this allowance is deductible as a trading expense, and means the amount left after any wear and tear allowances already given (with any sum realised by the sale of the old machinery, etc.) have been deducted, from the cost of the new machinery, etc. The new cost, however, then becomes the basis in the wear and tear list for subsequent yearly allowances, the old figures being taken out.

Certain rates apply to different classes of machinery, etc., under the wear and tear rule, and now by the Finance Act, 1938, all these are subject to an addition of one-fifth on former percentages, as example, the rate for motor vehicles is 20 per cent., add one-fifth (4 per cent.), and the rate now applying becomes 24 per cent.

Civil Defence Bill

Although strictly outside the scope of this article (and not yet law), the new Civil Defence Bill may usefully be mentioned. It makes compulsory certain precautionary measures, to be taken in the event of air raids, in respect of establishments employing over 50 persons (*e.g.*, equipping a percentage of workpeople in fire-fighting, first-aid and anti-gas measures). The items mentioned above under the heading "Civil Defence Expenditure," should be noted in relation to income tax matters as being deductible as trading expenses. Furthermore, employers with more than fifty employees in *vulnerable areas* will have to provide shelters for all workpeople. In this connection, and in relation to the new Bill generally, it should be distinctly understood that the Bill does not alter the fundamental principle in income tax law, that capital is outside and income is inside that

(*Concluded on page* 298.)

Molybdenum in Cast Iron

We published last week Dr. W. F. Chubb's Paper on "Molybdenum in Cast Iron." Below is a report of the discussion following its presentation to the London Branch of the Institute of British Foundrymen.

DISCUSSION

Composition of Base Iron

Mr. Charles Cleaver, having expressed his great appreciation of the Paper, referred to some castings which had been illustrated, containing nickel and molybdenum, and in which scrap was used to the extent of 80 per cent. He asked for the composition of the scrap used. Mr. Cleaver commented that throughout the Paper there was no indication of the other constituents used in the various mixtures—the ratios of silicon and manganese, etc.—apart from the molybdenum, nickel or chromium. Again, in the case of the irons illustrated, if the addition of 0.1 per cent. of molybdenum increased the tensile strength by only 1 ton per sq. in., it seemed that the expense incurred to secure that increase of tensile strength was rather considerable. At the same time, the tensile strength of the alloy irons was given as 37 tons per sq. in.; and if the use of molybdenum had increased the tensile strength by only 1 ton per sq. in., the original irons must have been of very good quality indeed. Inasmuch as the alloy irons were very expensive, he asked if the scrap had a corresponding value, and to what extent it could be used.

Use in Alloyed Irons

Dr. Chubb said he had no further details of the nickel-molybdenum irons referred to; but no doubt the Mond Nickel Company, or Mr. McRae Smith or Dr. Everest could give Mr. Cleaver the details he required.

Usually the silicon and manganese contents of irons were not modified greatly when molybdenum was added; but it was necessary to work out the alterations to suit each particular type of iron being made. He agreed that an increase of 1 ton per sq. in. in tensile strength was not very much for an addition of 0.1 per cent. of molybdenum; but he had made the point at the beginning of the Paper that where molybdenum alone was added, the cost was somewhat prohibitive. When molybdenum was present in conjunction with nickel in the ratio given, the nickel usually brought most of the improvements obtained, and the function of the molybdenum was then to intensify its benefits in certain directions. The reason was that molybdenum divided itself between the carbide and the ferrite, so that its influence was determined by the type of metal or other alloying addition used. If the other alloy added with the molybdenum happened to be a carbide former, such as chromium, then the molybdenum could act by solution in the ferrite, and there was then likely to be an increase in toughness. If, on the other hand, the chief element present was one which did not form a carbide, as was the case with nickel, then the molybdenum stabilised the carbides and brought about increased hardness and transverse strength. This was a rather curious property of molybdenum, and a very valuable property if applied correctly.

It was quite permissible to use every bit of scrap from the alloy irons; but, of course, one must know how much molybdenum or other alloying element the scrap contained. It was sometimes stated that, because one could use all the scrap available, there must necessarily be 100 per cent. recovery of molybdenum. That was rather a thin argument, however, because there were always losses, but the fact remained that molybdenum came back through the cupola into the metal in the ladle with only a limited loss.

Reverting to his statement that the silicon and manganese contents of irons remained approximately the same when molybdenum was added, he said that they depended, of course, upon the percentage of molybdenum added, upon the particular iron used and upon the type of casting to be made. One could not put forward any hard and fast rule in that connection. Formerly one had to work to rather wide limits even in making cylinder head castings and other castings of that type. He appreciated that since 1930-32 the efficiency of foundry practice had improved, and irons were being made in which the elements were controlled to within very close limits, so that there would be no difficulty in ensuring any silicon or manganese content required. In the ordinary way, it could be said that, with additions of molybdenum up to 0.5 per cent., there need be little change in the silicon and manganese contents. Above that molybdenum content, however, one would probably require to make considerable adjustment, because the molybdenum was a carbide-forming element and, on that account, greatly increased the hardness, so that sometimes it would be necessary to increase the silicon content to prevent chilling.

Use of Calcium Molybdate

Mr. P. A. Russell, B.Sc., asked what was the mechanism of the reduction of molybdenum from its oxide form in calcium molybdate, because a knowledge of that mechanism would help one to understand the use of calcium molybdate. He had used it very successfully in an air-type furnace, but he had never dared to use it in a ladle. From the Paper he had gathered, however, that provided sufficient time was allowed, it could be used successfully in the ladle, and he asked for an indication of the length of time that should be allowed.

Querying the author's reference to the use of larger risers, he said that in his own experience the use of larger risers for casting irons containing molybdenum had not been necessary; but possibly that was due to the fact that he used molybdenum only in irons which were originally of high quality, and in connection with which the risers used were already large.

Referring to Table III, showing the improved properties resulting from the addition of molybdenum to iron, he said he never liked to place much reliance on figures showing the results obtained before and after such additions were made to iron unless he was sure that he had a correct knowledge of the history. He asked whether the results given referred to exactly the same iron, with and without molybdenum, and of the same sectional thickness; he also asked whether the graphite was reduced in quantity as well as in size, because if the quantity of graphite was reduced, there was usually a reduction of size also.

Reduced Tensile but Increased Impact Strength

His experience of molybdenum in cast iron had been limited to nickel-molybdenum or nickel-chrome-molybdenum irons, and the increase of tensile strength resulting from the use of molybdenum, as claimed in the Paper, was not borne out by his experience. Indeed, he had found reductions of tensile strength when molybdenum had been added. He mentioned the case of two irons, from the same pour, with and without molybdenum; the tensile strength of the iron which did not contain molybdenum was 26 tons per sq. in., whereas that of the same iron to which 0.4 per cent. of molybdenum was added was only 24 tons. The impact strength had been improved very considerably as the result of adding molybdenum, and the Brinell hardness was increased. He could not agree, however, that the addition of molybdenum had trebled the impact strength of the iron. Test-bars were subjected to the single-blow impact test, of the form used by the British Cast Iron Research Association, and the impact strength of a nickel iron was improved from 10 to 12 ft.-lbs. by the addition of 0.4 per cent. Mo. The comparative figure for common iron was about 4 ft.-lbs. Therefore, he suggested that, whilst the impact strength of iron which contained molybdenum was treble that of ordinary common iron, it was not treble the impact strength of iron which was originally of high strength.

Early Charges and Sulphur Pick-up

Commenting on a statement in the early part of the Paper that, if one could not devote the whole blow of the cupola to molybdenum iron, one should run it first, he said he had found that to be a rather dangerous practice with nickel iron by reason of the affinity of the nickel for sulphur, tending to result in a high sulphur pick-up. He suggested that that might occur also in the case of molybdenum.

Discussing the final table shown by the author (Table III), indicating the improvements effected by adding 0.1 per cent. of molybdenum, he said he wished matters could be made as easy as they appeared in that chart. He asked whether the percentages of other elements added in the various cases were the same as the percentages of molybdenum; for example, did the statement "molybdenum with nickel" mean 0.1 per cent. of molybdenum plus 0.1 per cent. of nickel, and so on?

Finally, he complimented the author upon the Paper, and said it had encouraged him to go further in the alloying of cast irons.

The Via Media Taken

Dr. Chubb, replying, said that in order to decide what to include in the Paper he had examined a large volume of data from the United States, Germany, France and elsewhere, and had tried to work out, to illustrate the benefits to be secured, the tendency resulting from the addition of 0.1 per cent. of molybdenum. There were certain shortcomings in that sort of treatment, as Mr. Russell had pointed out. For example, when he had stated that 0.1 per cent. of molybdenum in a certain type of iron would result in a certain increase of transverse strength, he had meant that that was the order of increase to be expected no matter what was the nickel content of that iron. He was not surprised that Mr. Russell had picked him up on that point, because he appreciated that individual experiences were bound to differ. Indeed, if one compared the American, German and French research results it would be seen quite clearly that they were very often opposed to one another. For that reason it was very difficult to assess the value of molybdenum in cast iron from the points of view of transverse strength, tensile strength, Brinell hardness, and so on, and all he had attempted to do was to give an idea of the sort of increase to be expected when a percentage of molybdenum was added.

He had visualised that he would be addressing people interested in the subject, who wanted to know what they could do by adding molybdenum, what were its limitations, and whether it would pay them to use it. Rather than give a long list of properties or details of research, he had confined his attention to general tendencies; and if he had made it appear to be rather simple, he had done so deliberately, because he did not wish his audience to be left with a lot of figures and a confused mass of ideas. It was not really so simple; if he had claimed an increase of 1 ton per sq. in. in tensile strength as the result of adding 0.1 per cent. of molybdenum, and if somebody else had claimed an increase of 2 tons per sq. in., or if a third user had said that no improvement was noticed, he would not be surprised. The results he had given were average results, taken from a large number of researches, and he believed they represented the situation fairly accurately.

The mechanism of the reduction of molybdenum oxide in calcium molybdate was not very clearly known. Molybdenum oxide itself could be reduced to metal by any reducing agent such as hydrogen, silicon, aluminium or carbon. Originally, carbon was the reducing agent used,

but nowadays silicon and ferro-silicon were employed. He believed that in the cupola the conditions were such that carbon was the most active of the reducing agents present. There was not complete reduction, and some of the molybdenum oxide was not converted; but on an average one would get 95 to 96 per cent. of the molybdenum in the casting.

The use of larger risers when casting irons containing molybdenum was recommended on account of the fact that molybdenum tended to make the iron somewhat sluggish. They were used as the result of the experience of quite a number of American firms, but he had gathered that Mr. Russell had not found it necessary in all cases.

Mr. Russell said he had found no increase of shrinkage when he had added molybdenum to iron which had already a high shrinkage before molybdenum was added to it.

Influence on Graphite

Dr. Chubb, referring to graphite content, said that when molybdenum was added in small amounts the total graphite content was not affected appreciably. When the molybdenum content was above, say, 0.5 per cent., the effects of carbide stabilisation began to be felt, so that the total graphite content was progressively reduced as molybdenum content increased; and irons containing approximately 2 per cent. of molybdenum had their carbon very largely in the carbide form. Generally speaking, it could be said that molybdenum, in small amounts at least, made little difference to the total graphite content, but it had quite a pronounced influence on the distribution and size of the graphite flakes. The two photomicrographs which he had shown, indicating differences of structure, were of irons of exactly the same composition except in respect of molybdenum, and they were each cast in exactly the same way, the castings being of the same size.

As to the rather curious result mentioned by Mr. Russell, indicating that the effect of the addition of molybdenum was to reduce tensile strength, he could not quite appreciate how that could be explained, unless there were some other controlling factors. The figures given in the Paper, showing that the impact strength of iron was greatly increased when molybdenum was added, were provided by the Climax Molybdenum Company of America, who were producers of molybdenum; but it was not possible for him to confirm that because very little work had been done on that aspect of the subject. That tendency could nevertheless be anticipated on the basis of modern metallurgical theory. Quite a lot was being done, however, more particularly regarding the influence of nickel and chromium. He was not surprised that Mr. Russell had disagreed with the figures concerning the effect of molybdenum on the impact strength of irons; that fact served to show that the subject was somewhat controversial, that the results to be obtained were variable, and that a new user of molybdenum must not expect too much to begin with.

Size of Test-Bar Taken

Mr. McRae Smith, in congratulating Dr. Chubb upon his Paper, said that he had made under-statements rather than over-statements. Commenting on the point that, as shown by the figures obtained by the Climax Molybdenum Company of America, the impact value of iron had been trebled when molybdenum was added, he asked what size of test-bar had been used by that company in their tests, and what was the initial impact value of the cast iron without the addition of molybdenum. Reference had been made, he said, to the Izod bar; but presumably the test-bar used in the case mentioned was not the ordinary Izod bar as used for steel and which, if used for cast iron, might give only a fraction of the figure.

Recalling the use of the word "ductility" in the Paper, he asked whether the author had actually meant ductility as the term was understood in respect of other materials, or whether he had been discussing rather a resistance to shock and comparing in that respect a moderately high-strength iron and a molybdenum cast iron or a nickel-molybdenum cast iron.

He was not at all happy with regard to the author's statement that total carbon should be kept at a low figure in molybdenum cast iron in order to reduce the tendency of the molybdenum to chill, because molybdenum was a carbide former. He asked for some further information, therefore, on that matter.

Dr. Chubb replied that he had not at hand the exact dimensions of the impact test-pieces used by the Climax Molybdenum Company, but he promised to supply the information to Mr. McRae Smith.*

In the Paper the term "ductility" had been used in a rather more general sense than was usual when speaking of the ductility of steel; his use of the term was really meant to convey the meaning of shock toughness, as Mr. McRae Smith had suggested.

With regard to total carbon content, he had meant to imply that when that content was limited there was less likelihood of variable hardnesses in molybdenum cast iron; that the irons would be more uniform in hardness, and generally sounder. He believed that was quite a common experience amongst motor-car manufacturers in the United States—and he had obtained most of his information from the American technical Press and from users in that country.

Vote of Thanks

Mr. G. C. Pierce (Past Branch-President), proposing a vote of thanks to Dr. Chubb, commented that whereas he could have given a Paper of a highly academic nature, he had in fact dealt with his subject in a practical way which all could understand and appreciate.

Mr. V. Delport (Past Branch-President) seconded the vote of thanks.

* Dr. Chubb has since supplied the following information:—Specimens for impact tests on cast iron have been 0.79 in. square or 0.79 in. round, and with unalloyed cast iron the shock toughness is then found to be about 20 ft.-lbs. when broken in the Izod machine. In other instances test-pieces of 1.125 in. diameter have been employed, and specimens of these dimensions in nickel-molybdenum cast iron cannot be broken in the 120 ft.-lb. Izod impact tester. This fact clearly illustrates the exceptional properties to be obtained by adding both nickel and molybdenum to cast iron.

Foundry Time Studies*

By R. F. Coates.

Everyone responsible for the fixing of foundry piecework prices knows that difficulties are often encountered in arriving at a correct price or time allowance for various jobs. The practice of setting a price by comparison with previous work, and from experience, is basing it upon what has been done and not what might be done. If Jones makes a certain job in 2 hours and is allowed 3, and later the same job is given to Smith who makes it in 1 hour, it is obvious that the price was fixed by what had been done and not by the time necessary for the job, which Smith proved. A time study on such a job would have resulted in a more accurate price being fixed when the job was first issued.

If one moulder is overdrawn in time on a particular job, and another is earning exceptional bonus, assuming that they both are equally skilled and good workers, something is obviously wrong with the price of each job. A time study in two such cases would adjust each to a correct price, which gives each man an opportunity to earn a reasonable bonus. It therefore follows that prices fixed from experience and by comparison are estimations, and however accurate, remain as such, whereas a time-study price is based upon that time which has been accurately recorded on the job

It is unnecessary to apply a time study to every job, but from the studies taken, a wealth of information regarding standard times can be collected and filed for reference. Practical foundry experience is essential to the time-study investigator, as the whole point of rate-fixing by time study is to produce a given mould with the smallest number of operations necessary as is consistent with the producing of a good casting. It may be necessary, therefore, for the investigator to point out any operation that is, or is not needed, and only practical experience will enable him to do so. It will also assist in securing the confidence of the men, in that they will know that their work is being timed by one who knows what moulding is. With the addition of common sense, a keen sense of observation, and tact, the foundry rate-fixer should have little difficulty in fixing prices which are fair to both employer and worker.

Setting-up Time

In some machine shops, a setting-up time is allowed for a particular job. Such an allowance can be made to the moulder, either machine or hand, in the form of preparation time to cover collecting patterns, boxes, etc., and setting-up in case of machine-moulding. In beginning such a time study, the investigator should see that all tackle and materials are at hand, so that they can be reached with a minimum of effort. When the operator begins, he should if necessary be informed of the various operations in their correct order, and before timing begins it should be noted that the moulds are being made according to the instructions. Each mould made by the same operations, in the correct sequence, produces a rhythm which enables the operator to get the best results with a minimum of effort.

With a list of these operations, the time-study man records the times taken. In practice it is hardly possible to time each in its correct order on one mould, as while the time of one operation is being recorded the next has begun. It will be more convenient to record alternate operations. Care must be exercised in the use of the stop-watch by starting and stopping at the same point of the beginning and ending of a given operation. For instance, time the riddling of sand on to pattern, from the time of the picking up of the sieve to its being replaced.

(*Continued from next column.*)

Any number of studies can be taken, but this depends on nature and size of the job, from which the average can be taken to form the basis of the final allowance. An overall floor-to-floor time can be taken to check up on the individual times, and if both have been taken accurately they should agree within reasonable limits. The timing must include every operation from the mounting of the box on the machine to the completion of the cast, or to whatever point the operator's work ceases on the job.

When applying a time study to larger work, the methods are necessarily altered. It is possible to time each operation as it is being done on one mould, as the operations are of longer duration and allow ample time to record them in the correct order, such as ramming drag 8 a.m. to 8.30 a.m. (30 minutes), roll over and make joint 8.30 to 8.40 a.m. (10 minutes), and so on to the end of the job. Where two or more men are on a job, times must of course be doubled or trebled according to number of men engaged.

It is important, particularly on larger work, that moulders should not be allowed to do any work which can be done by labourers, for if such work is taken in the time study and allowed for, it will prove unduly expensive. The investigator must at all times exercise great care in recording times, as it depends upon his figures that the final price is fixed. He should also note any slackness on the part of the men, any waiting times, such as for crane, or materials. All such information should be included in his time-study report, and discussed with the foundry foreman.

(*Continued in previous column.*)

* Paper read to East Anglian Section of the Institute of British Foundrymen.

Nickel in the Non-Ferrous Foundry

By F. HUDSON

(*Concluded from page* 266.)

The fundamental facts outlined relative to moulding methods required for the making of good test bars can obviously be applied to the general production of non-ferrous castings and in particular to the 5 per cent. nickel bronze under consideration. In fact, it has been noted from personal observation that many of the most successful founders producing pressure castings are actually using similar gating practice to that outlined, as shown, for example, in Fig. 8. Suggested points to be aimed at in obtaining maximum density and freedom from porosity can be outlined as follow:—

(1) Pour at a suitable temperature and in such a manner as to obtain proper heat and metal distribution in that part of the mould forming the casting. Heavier sections should be the last to solidify and suitable steps taken to supply hot metal at these parts for feeding purposes.

(2) Employ well proportioned risers on sections requiring feeding and arrange that the metal in the risers is hotter than that in the casting.

(3) Adopt choke gates for cleanliness and pouring control.

Fig. 8A.

Fig. 8B.

Figs. 8A and 8B.—Successful Methods of Running Test Bars can be readily Applied to Castings as shown.

A.—Valve body in Bronze containing Ni 5, Sn 5 and Zn 2 per cent., and balance Cu, tested to 1,000 lbs. per sq. in. without leakage. B.—Water heater shells in gunmetal containing Ni 2, Sn 8, Zn 5 and Pb 5 per cent., and balance Cu. These castings are only ¼-in. section.

(By courtesy of Phosphor Bronze Company, Limited.)

Incorrect Pouring Temperature

The effect of pouring temperature in the production of non-ferrous castings is fully appreciated by every practical man, and there is no doubt that for the majority of bronzes, the best results are obtained by pouring at a certain degree of super-heat determined by the composition of the metal in conjunction with the design and mass of the casting. This point has formed a frequent topic for discussion in the past, and it is not proposed to deal with this matter at any length in this Paper. There is, however, one aspect which might well be given some additional thought, namely, the reason for the rather narrow and critical range of pouring temperatures at present experienced in the foundry, particularly when handling the copper-tin alloys. Consider for a moment the foundryman who has to cast a large number of pressure sections. How often it is found that those towards the end of the pour turn out "leakers," whilst, if the initial temperature at which pouring commences is increased, the trouble is probably transferred to the first castings through "tin sweat." The reason for the production of defective work through the use of too low a casting temperature is obviously due to the inability of cold metal to feed properly, but a suitable explanation for the occurrence of "tin sweat" is not so easily defined.

Various investigators in the past have suggested that this liquation of metal is caused by the contraction of the outer skin of the casting. Others have suggested that it is due to the evolution of dissolved gases, and in the light of present knowledge this last factor appears to offer the most acceptable explanation. All molten metals dissolve gas, some more than others, and it is feasible to contend that if steps are taken to prevent gas absorption, or, alternatively, de-gasify before casting, the effect of pouring temperature will not be so critical. In other words, the permissible practical range accepted as giving the best results could be extended by the use of slightly higher temperatures without serious reduction in casting density or mechanical properties and without fear of the occurrence of liquation or "tin sweat." Lepp[6] has demonstrated that the mechanical properties of nearly all the standard non-ferrous alloys can be considerably improved by degasification, as will be observed from Table II. With properties such as these, one can afford to take some liberty with casting temperature.

A suitable pouring temperature for any particular casting should primarily be determined according to the metal section in its thinnest parts. This will, in the majority of cases, entail the use of a slightly higher temperature in the heavier sections, but this is an advantage rather than otherwise, providing definite precautions are taken for feeding, and the metal is free from gas. Far too many foundries today harbour the idea that heavy sections should be cast as cold as possible. It is impossible to obtain proper feeding with consequent maximum density and freedom from interdendritic shrinkage by such practice.

There are, of course, other methods of obtaining casting solidity in addition to the above. Controlled cooling by the use of chills is feasible but so often impracticable in many cases. Mention might, however, be made of the possibilities arising through the effect of alloy additions. It has been found, for example by Pilling and Kihlgren,[7] that small additions of nickel appear to have a real effect in reducing the grain size. In the usual range of pouring temperatures the refinement averages about 50 per cent. reduction in grain diameter for 1.5 per cent. nickel or less. This point is of importance as it will counteract to some extent the effects of slightly increased pouring temperatures on grain size, and consequently should be considered in conjunction with the factors previously discussed. Small additions of nickel also have the curious effect of imparting increased fluidity to bronze and gunmetal. No satisfactory explanation can be given as to how this arises, but the fact that it does happen is not only of technical interest but of considerable value to the practical foundryman, extending the effective range of pouring temperatures in the reverse direction.

Another effect of nickel additions is to promote solidity as shown in Fig. 9. This illustration outlines a series of T-shaped test-specimens containing various percentages of nickel, cast from a base alloy containing 5 per cent. tin, 5 per cent. zinc, 5 per cent. lead, balance copper, and poured over a range of temperatures between 1,090 and 1,260 deg. C. The test-specimen was a ¾-in. thick, 3-in. square plate, with a ¼-in. thick by 1½-in. deep rib extending across its face. These were moulded in pairs in green sand, with the rib down, using a horn gate and heavy risers. The series of specimens were cut into transverse slices, which were subjected to examination. The unsoundness resulting from excessively high pouring temperatures is strikingly evident, but the progressive action of nickel in reducing this porosity, first in the rib and then in the heavier section, is brought out quite clearly. At lower pouring temperatures the general soundness is greatly improved, but the trend of nickel in promoting density still may be traced. For example, in the series of castings poured between 1,230 and 1,260 deg. C. even the ¼-in. thick rib section is very porous. The addition of 0.5 per cent. nickel reduces the porosity appreciably in this thin section, and it is completely removed

Table II.—*Composition and Properties of Bronzes.*

Composition.					Tensile strength. Tons per sq. in.	Elongation per cent.	Brinell hardness.
Cu.	Sn.	Zn.	Pb.	P.			
88	10	2	0.5	—	20.3 to 23.5	40 to 70	70 to 90
85	8 to 9	4 to 6	1 to 2	—	19.0 to 21.6	35 to 62	70 to 75
85	5	5	5	—	17.8 to 19.0	35 to 47	60 to 65
90	10	—	—	0.1	20.3 to 23.5	40 to 65	70 to 80
87	13	—	—	0.1	20.3 to 22.9	10 to 20	90 to 100

by 2.0 per cent. nickel without reduction in pouring temperature.

Fig. 10 affords an interesting practical example of the use of nickel additions in the production of non-ferrous castings. These castings must stand steam pressure and have an average thickness of about ¼ in. They are cast in an alloy having a composition very similar to that used for the shrinkage tests just outlined, and they must be poured at a high temperature in order to get them to run satisfactorily. An addition of 2.0 per cent. nickel is made to ensure maximum density and pressure tightness and to

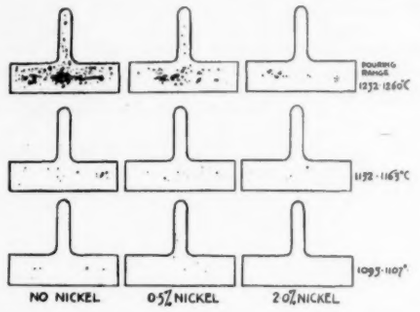


Fig. 9.—Effect of Nickel on Shrinkage of 85/5/5/5 Alloy.

counteract the effect of high pouring temperature. Without the nickel content, satisfactory results would not be so readily obtained.

It has also been found that nickel increases the strength and toughness of many brass foundry alloys, and this increase in mechanical properties bears an important relation to the problem of pouring temperatures. For instance, consider a typical gear-bronze containing, say, 11.5 per cent. tin and 87.5 per cent. copper. With good practice it is possible to obtain around 18 tons tensile with 15 per cent. elongation. If 1.5 per cent. nickel is added mechanical properties are increased to 24 tons tensile with 19 per cent. elongation. Obviously the possibility of obtaining excessively low test figures through variation in casting temperature is less in the case of the alloy having the higher properties. There is one point, however, which must be kept in mind when making nickel additions to non-ferrous alloys, and that is the fact that, like cast iron, the amount required and the final properties obtained are largely dependent upon the nature of the base alloy. Present knowledge upon this matter has been fully recorded elsewhere.[8]

Reverting for a moment to the 5 per cent. nickel bronze under consideration, a range of pouring temperatures between 1,200 and 1,290 deg. C. has given satisfactory mechanical properties so far as test-bars are concerned, and this may be modified for casting requirements to, say, 1,180 deg. C. for heavy work, 1,200 to 1,220 deg. C. for medium and 1,220 to 1,290 deg. C. for light castings. It is, however, very important to keep in mind that no dogmatic statements can be made in connection with pouring temperature as this will depend upon individual practice; but there is no doubt that this would not be the bogie it is if foundrymen appreciate the assistance to be afforded by additions of other metals, such as nickel, in conjunction with a full knowledge of those factors relative to the prevention of gas absorption or, alternatively, its elimination. The possibility of using higher pouring temperatures than those generally considered satisfactory to-day, together with proper gating methods, would lead to better and denser castings in many instances.

The design of many castings, particularly those embodying severe change in section, requires metal which will maintain the highest physical properties over a wider range of pouring temperatures than has been found possible in the past, and the factors given above warrant serious consideration by every foundryman.

Before leaving this subject there is another aspect which should receive mention, namely the loss of temperature through crucibles. The latest high heat-conductivity crucibles are undoubtedly of great advantage so far as rapid melting is concerned, but during the casting operation they permit the metal to cool down much more rapidly with consequent difficulty in maintaining a specific range of pouring temperature. There is a need for a refractory lagging to surround the crucible to prevent this, and one might visualise a crucible within a crucible. The inner crucible to have high heat-conductivity to give rapid melting, the outer to have the lowest possible conductivity to minimise cooling. This latter could be split vertically down the middle and sit in the crucible carrier to receive the melting crucible as it came from the furnace.

Table III.—*Properties of Flux Materials.*

Material.	Chemical formula.	Colour.	Approx. melting point. Deg. C.	Oxygen dissociation on heating. Deg. C.	Remarks.
Cupric oxide	CuO	Black	1,150	1,100	Strong affinity for hydrogen and evolves oxygen at yellow heat.
Cuprous oxide	Cu_2O	Red	1,240	Nil	Reduced by hydrogen to metallic copper. Does not evolve oxygen when heated.
Manganese-dioxide (manganese ore).	MnO_2	Black	1,300	700 to 800	Evolves oxygen above a red heat.
Barium-peroxide	BaO_2	White	2,000	450 to 700	Evolves oxygen below a red heat.
Barium carbonate	$BaCO_3$	White	1,400	—	Reduces slag fluidity. Good desulphuriser.
Calcium oxide (lime)	CaO	White	2,250	—	Useful for hardening slag to facilitate skimming.
Sodium carbonate (soda ash) ..	Na_2CO_3	White	850	—	Useful for controlling slag fluidity and fluxing dirt. Tends to reduce sulphur.

Gas Absorption Due to Improper Melting and Deoxidation Methods

No matter how well a mould is made or poured the best castings will never be obtained until every foundryman appreciates the important effect gases have on cast metals. Even the most skilled metallurgist, as yet, does not understand all the reactions which take place when metals are melted, but enough has been discovered to indicate possible practical ways of minimising trouble due to this cause. The first point to aim for is to ensure an oxidising atmosphere during melting, and the ease with which this is obtained and maintained will naturally depend upon the melting furnace available.

The premier furnace for non-ferrous melting is undoubtedly the electric induction furnace, preferably of the high-frequency type. Such furnaces enable the metal to be melted rapidly in contact with air, containing 20 per cent. oxygen, and furthermore the induced current in the molten metal causes a natural circulation to take place which ensures that the oxygen is effectively distributed to the metal. In addition there is the great advantage that harmful gaseous products of combustion are entirely absent. It might be considered that an

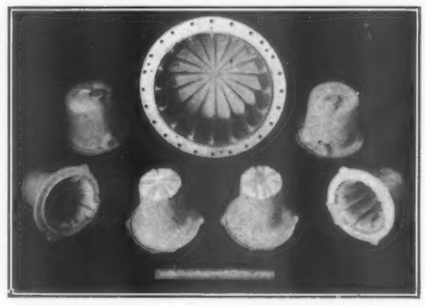


Fig. 10.—Dressed Water Heater Shells as shown in Fig. 8b.

An addition of 2 per cent. Ni is made to ensure maximum density and pressure tightness, and to counteract effect of high pouring temperature demanded by the thin section and large surface area. (By courtesy of Phosphor Bronze Company, Limited.)

atmosphere containing 20 per cent. oxygen is excessively oxidising for many alloys handled in the brass foundry. Such has not proved to be the case when handling gunmetals, bronzes and a wide variety of nickel alloys. Furthermore, it must not be forgotten that the effect is probably indirect, the oxygen first combining with the base metal to form oxides, and these in their turn acting as a direct supply of oxygen for the removal of deleterious gases dissolved in the metal such as hydrogen. It has also been noted that in the melting of nickel in contact with carbon in the high-frequency furnace there is no difficulty in obtaining carbon absorption which tends to substantiate that the melting atmosphere is not unduly oxidising. Another interesting point in connection with the operation of this type of furnace is the fact that the atmosphere is constant and cannot be altered by normal furnace control, quite opposite to, say, an oil-fired unit where the atmosphere can be made reducing or highly oxidising according to the setting of the oil or air valves.

Next to the electric induction furnace, the arc type may be profitably considered for modern non-ferrous practice. Furnace design and operation play an important part in obtaining successful results with this method of melting, and it is desirable that oxidising conditions should be assured by having free access of air (*i.e.*, oxygen) to the metal. Current and electrode consumption should be so controlled as to prevent neutral or reducing conditions arising, and excessive overheating of the metal avoided. Alternatively, there appear to be no obvious reasons why furnaces of this type should not be operated with oxidising slags in order to obtain good results, particularly in view of the fact that they can be readily lined with basic material. The best of the refining slags, as, for example, those used by Lepp, have a severe cutting action on graphite crucibles and acid refractories and a basic-lined furnace is the obvious solution to this difficulty. In addition the shape of the hearth in most arc type furnaces is particularly suitable for obtaining good reactions in view of the excellent ratio of surface area to depth of the molten metal bath.

It is, however, to either the oil or forced-draft coke-fired crucible furnace that the average founder in this country will look for obtaining his molten metal requirements, and of the two, oil firing has probably the greater advantages. It provides relatively rapid melting and, with care, can be controlled to give the required oxidising conditions. In the case of open-top furnaces, the presence of free oxygen can be easily observed by the colour of the exhaust flame which should be transparent yellow with a green edge bordering to yellowish green. The depth of the greenish tint is roughly proportional to the amount of oxygen present. If the furnace has an exhaust flue connected to a stack the flame cannot, of course, be observed, and the combustion gases should be analysed to determine the oxygen content at various settings of the oil and blast valves. Once a satisfactory setting has been determined, say to give from 0.2 up to 0.8 per cent. oxygen, this should be maintained by careful supervision. There is one objection relative to the standardisation of furnace atmosphere by analysis, inasmuch as many non-ferrous foundries do not employ a chemist or metallurgist. Steps should be taken to correct such an omission at the earliest opportunity, but in the meantime, thanks to metallurgical research, positive oxidising conditions can be obtained if necessary without analysis by use of slags or fluxes which evolve oxygen when heated. This point is of very great importance in connection with the production of the best quality metal from natural draft coke fired furnaces which in the majority of cases operate with a reducing atmosphere, and are, therefore, most unsuitable for obtaining the best results.

Manganese-dioxide (MnO_2), black cupric oxide (CuO), red cuprous oxide (Cu_2O), nickel oxide (NiO) and barium peroxide (BaO_2) can all be usefully employed. Lepp's degasification process,[6] which is probably the most effective, utilises a balanced mixture of oxides in conjunction with other fluxing materials, such as soda ash or barium carbonate. In addition there are several proprietary fluxes on the market which work extremely well. Some of these have, however, the disadvantage of reducing crucible life appreciably. The amount of flux required and the method of using essentially depend upon its composition and existing melting conditions. Generally speaking, there are two main methods of utilising oxidising fluxes. In one case the addition can be made with the charge before melting commences, so that the flux is in contact with the metal all the time, or, alternatively, the addition can be arranged after the metal is melted and prior to the addition of deoxidisers.

The first method is of value when furnaces giving a reducing atmosphere have to be utilised, such as natural-draft coke-fired units. It is advisable to cover the crucible to concentrate oxidising conditions as far as possible, and it may be necessary to add further quantities of flux during melting if this is unduly prolonged. An addition of 1 to 2 per cent. manganese-dioxide or cupric oxide is usually ample, and will safely cover melting times up to 2 hours. For longer periods than this, half the flux should be added initially, followed by the balance about midway through the melting period.

In the case of the second method this is preferably recommended to assure complete degasification of alloys presumably already melted under oxidising conditions. Cuprous oxide is usually most favoured for this purpose and is added in an amount around 0.2 per cent. by weight of the charge, for virgin metal heats, and reduced to 0.1 per cent. for the more usual foundry heats embodying up to 50 per cent. remelt. Cupric oxide can also be employed for this purpose, particularly as it has a greater oxidising action and a greater affinity for hydrogen. Hydrogen reduces black copper oxide at below a red heat, and the reaction is so vigorous that the oxide actually glows. Accordingly it might be suggested that cupric oxide can be utilised for the treatment of metal containing a large amount of dissolved gases, whilst cuprous oxide can be employed for less severe cases. In practice the oxide is either placed on the metal surface and stirred in or plunged. In either case its addition is characterised by considerable disturbance in the crucible due to the release of gas from the metal.

It is a common belief amongst bronze founders that the use of remelted metal gives better results than when all virgin materials are employed. This is only true when no degasification treatment has been employed, and it is rather interesting to note that if an all virgin metal heat is melted under oxdising conditions and then treated with copper oxide, no difference in properties can be detected over a similar heat made from remelt. Table III outlines the main characteristics of the most useful flux forming constituents likely to be of service for non-ferrous melting.

In connection with the 5 per cent. nickel bronze under discussion the following procedure[7] has been found to work well in oil-fired crucible furnace heats using virgin metals:—

(1) Melt down the copper and nickel using a moderately oxidising flame.

(2) When thoroughly melted, oxidise the heat with 3 ozs. of cuprous oxide to 100 lbs. of metal, stirring in the oxide with an iron rod. Hold the heat 3 to 5 minutes.

(3) Deoxidise the melt with 3 ozs. of 15 per cent. phosphor copper per 100 lbs. of metal.

(4) Add the zinc followed by tin.

(5) Finally, complete the deoxidation by a further addition of 4 ozs. of phosphor copper per 100 lbs. of metal.

A further interesting point relative to the effect of dissolved gases, observed when handling this alloy, is the fact that melts treated with copper oxide respond more vigorously to age hardening. It is, of course, essential to deoxidise thoroughly all alloys which have been given an oxidising treatment and for the majority of bronzes and gunmetals phosphor-copper is particularly suitable for this purpose. Two final points in connection with melting and gas absorption—*Do not use charcoal as a cover and do not use wet coke.*

Space does not permit outlining many other points that might be raised relative to non-ferrous foundry practice. The principal factors of gating, pouring temperature and melting have been covered (it is hoped) from a modern, but at the same time an essentially practical, outlook. There is only one matter remaining—namely, the future possibilities in connection with the heat-treatment of castings. It is possibly true that in the past some foundrymen have had experience of this operation for reasons best kept to themselves. The improvements obtained, however, in respect of bronzes containing, say, 5 per cent. nickel, are most marked, providing certain precautions are taken. The need for the prevention of interdendritic shrinkage and porosity has already been mentioned, but there is another point which must be considered, that is, the effect of impurities, particularly lead, and to a lesser degree silicon. The latest work by Kihlgren[8] indicates that the presence of as little as 0.05 to 0.10 per cent. lead retards or completely inhibits response to heat treatment. Small amounts of silicon also tend to prevent age-hardening taking place, and it is accordingly desirable to ensure the absence of these elements if the best results are to be obtained. In regard to the heat treatment operation itself, there are several methods open to consideration for obtaining increased mechanical properties. In the initial investigation of the 5 per cent. nickel bronze, it was found that maximum properties were developed by first homogenising at 760 deg. C. for periods up to 10 hours and quenching in oil or water, followed by a low-temperature age-hardening treatment at 290 deg. C. for 5 hours. Whilst such a treatment gives the highest mechanical properties, it has two practical objections. In the first case, it is rather expensive to conduct and, secondly, with castings of a certain design, the initial quenching operation from 760 deg. C. is liable to cause distortion. Latterly, it has been found that these objections can be completely overcome by reducing the homogenising period down to a minimum of 2 hours without sacrifice in the optimum properties obtained, or, alternatively, omitting it entirely and ageing the castings direct as they come from the sand. Whilst the last suggestion does not develop maximum properties, the improvements are such as to constitute a distinct advance in the practical metallurgy of the bronzes, giving simple means for obtaining highly attractive properties for many purposes, namely:—Maximum strength, 27.0 to 32.0 tons per sq. in.; yield point, 18.0 to 27.0 tons per sq. in.; elongation, 16.0 to 5.0 per cent.; Brinell hardness number, 120 to 170.

There is a need to-day for really high-grade castings, and it is only by considering some of the points raised that the non-ferrous founder can hope to increase the standing of the industry and produce a material that will contend with the increasing demands of modern times.

REFERENCES.

6 H. Lepp. "Mechanical Properties of Some Tin Bronzes." Tech. Publ. International Tin Research and Development Council, Series D, No. 3.

7 N. B. Pilling and T. E. Kihlgren. "Casting Properties of Nickel Bronzes." Trans. Amer. Foundrymen's Assocn., 1932, Vol. III, pp. 289–305.

8 N. B. Pilling and T. E. Kihlgren. "Some Effects of Nickel on Bronze Foundry Mixtures." Trans. Amer. Foundrymen's Assocn., 1931, Vol. II, pp. 93–110. See also Mond Nickel Co., Ltd., Publication D.11.

9 Brit. Pat. 429,440. See also H. Lepp. "Deoxidation and Degasification of Metals. Developments in Refining Methods." Metal Ind. (Lond.), 1935, Vol. XLVII, pp. 315–18, 341–345.

Catalogues Received

Fluxes. With the January-February issue of "Foseco News," issued by Foundry Services, Limited, of 285, Long Acre, Nechells, Birmingham, 7, were enclosed three leaflets. They cover "Cuprex," a proprietary material for maintaining a slightly oxidising condition whilst melting a number of non-ferrous alloys; "aluminium remover" for application to copper and nickel alloys, and Shot 33, for improving the physical properties of gunmetals and bronzes.

Pipe Joints. It is stated at the beginning of an exceptionally well-illustrated catalogue sent to us by the Staveley Coal & Iron Company, near Chesterfield, that no attempt has been made to include all types of joints used in connection with cast-iron pipes. Yet the range included is extremely wide, and the ingenuity displayed in many of the designs is commendable. Some of the special-duty joints, such as those to be used in connection with high-pressure hydraulic mains or for carrying a main across a river bed, are especially ingenious. The catalogue carries 44 admirably laid-out pages.

Midland Electric Manufacturing Company, Limited

At the annual meeting of the Midland Electric Manufacturing Company, Limited, Sir C. Herbert Smith (chairman) said that during the year the erection of the duplicate foundry plant had been completed, and had enabled the company to produce its requirements of castings with a single shift working, thus effecting considerable economies. The extension and equipment of the factory at Tyseley, to which they removed in 1937, was now complete. The manufacturing plant which the company possessed was unique in this country for the specialised production of the range of manufactures which it undertook. During the year the designs of their range of motor control gear had been reviewed, and last autumn an improved range of this gear was introduced to the market.

Some Impressions of American Enamelling Practice*

By J. H. GRAY

The general programme as carried out and a list of the plants visited during the Institute's official visit to the United States can be summarised as follows:—

On Monday, October 10, the members travelled from New York to Baltimore, where they visited the Porcelain Enamel Manufacturing Company's plant and that of the Baltimore Enamel & Novelty Company. On Tuesday they proceeded to Clairton to see an enamel housing scheme, and then went on to the Carnegie Illinois Steel Company and to Ingram-Richardson's plant at Beaver Falls. Wednesday was devoted to a visit to the American Rolling Mills at Dayton, and on Thursday and Friday the party participated in the Porcelain Enamel Institute Forum at Urbana. On Saturday, October 15, members saw at Chicago the plant of the Chicago Vitreous Enamel Company, while Sunday was spent sightseeing in Chicago. The visitors proceeded on Monday, October 17, to Cleveland and visited Ferro Enamel Products' plant, whilst the next day, at Detroit, they inspected the Briggs Manufacturing Company and attended the Metal Trades Congress, returning from New York to England on Wednesday, October 19.

Before giving what might be termed personal general views on the tour of a number of United States steel and enamelling plants, the author would like to mention the very cordial reception given to the party by members of the Porcelain Enamel Institute, and particularly Mr. F. Hodek, jun., the chairman, who obtained special permission to board the vessel outside American waters in order to sail into New York Harbour with the visitors.

Mr. Hodek also honoured the party by participating in the whole of the tour, and in fact he was a particularly assiduous *factotum* during the whole trip. We arrived in New York on Sunday, October 9, and proceeded to the hotel, where a meeting was held and final arrangements were made regarding the method of travel and the plants to be visited. At this meeting each delegate was handed an attractive little book, leather bound, which was printed especially for our benefit, giving a list of the plants to be visited, the date on which they were to be visited, and ample space was allowed for making notes in connection with each plant.

It will be appreciated that these remarks must be confined to the actual plants visited. It will be realised that there are many more plants of great interest that could have been visited had time permitted. It is a personal hope that some day an opportunity of visiting these will occur. It is the opinion of those who visited the United States that, whilst the stamping of the signs and other sheet metal work, including table tops, is superior in general design to those manufactured in this country, the enamelling finish on the whole is no better than that obtained here. In several cases it is below the usual British standard.

The enamelling plants, generally speaking, are not so neat and tidy as the average British plant. Moreover, the type of labour employed in the American shops appeared to be of a lower class than that usually found in British plants. This, personally speaking, is probably due to the large amount of mechanisation which has been introduced into the American plant layouts, and less skill is required by the operators than is the case here.

With regard to fuel, it was evident that they are not so worried about the amount consumed as is the case here, due to the fact that they have their own gas wells or generate their own electricity. Even those firms buying their gas, which has a calorific value of 950 B.T.U.s as against our 480 to 500 B.T.U., only pay 1s. 8d. per 1,000 cub. ft., which is quite close to our average cost, and get almost double our value. It is certain that some of the enamellers in this country would be very deeply concerned if they saw in their plants, for instance, the amount of gas that was being used to heat a drier as was noted in some of the American plants.

Pickling

Whilst the majority of the plants in America use sulphuric acid, and not muriatic, this was, it is understood, due to the fact that sulphuric acid can be purchased much cheaper than the latter, but one or two enamellers did say that actually they preferred muriatic.

The American frit manufacturers, like the British, have had to spend a considerable amount of money on scientific instruments for control purposes. Quite a lot of work in this direction appertains to architectural enamelling. It appeared that there had been a great deal of competition among the frit suppliers in the States, and all of them had invited customers and prospective customers to their plants, consequently each of those visited appeared more showy than the average British plant.

The operating of the frit manufacturing plants is, of course, done on a very large scale, and owing to this mechanisation has been applied considerably, but in comparing the output of these plants with those of the British manufacturers, the conclusion was reached that should they be faced with the same production problems it *might* be necessary for them to do the same.

As far as the actual process of frit-manufacture is concerned, such as sieving, hand-picking, and magnetic separation, etc., there is nothing they do that is not done in this country by frit manufacturers, and it is a personal opinion that British manufacturers are in a position to pay closer attention to these matters than are the Americans. This conclusion was reached after noting that they had one man doing the job that one man does in this country, but the American had approximately ten times the output claiming his attention.

It is interesting to note that owing to the dry climate frit manufacturers are able to pack all frits in paper bags, but these are not so suitable as the dust and waterproof bags which are used in this country. Referring again to the dry atmosphere, it was a pleasure to see the brightness of the iron that was being processed in the pressing shops, and without doubt it looked cleaner than that often received from the pickling rooms here. The iron used is high quality ingot iron almost without exception.

Regarding the Porcelain Enamel Institute Annual Forum, this cannot be compared with the Annual Institute Conference, as it is run on entirely different lines. At the Forum far more time is given to the delivery of Papers and general enamelling discussions. Altogether there were 24 Papers delivered, and tours were made of the Ceramic House in the University buildings at Urbana.

Perhaps the author had been misled by publications received from America, prior to the trip, but he certainly expected to see more enamelled buildings than was actually the case. He understands that this branch of enamelling is still in its very early stages, and experiments are being made with different types of enamel and different methods of fixing.

Cast-Iron and Lead-Bearing Enamels

Unfortunately, the party did not visit any plants producing bulk quantities of cast iron enamelware either by the dry or by the wet process, and the impression was gained that the enamelling of cast iron was dying out and articles, wherever possible, were being made of steel instead.

It seems that there are not the same restrictions against the use of lead-bearing enamels in America as is experienced here, and for that reason, if any serious trouble occurs with a leadless enamel, such as blistering, they do not spend any considerable amount of time in tracing the cause of the trouble, but seem to prefer to change over to a lead-bearing enamel, and it is for that reason that it is felt that in this country the technique is further advanced in the manufacture and application of wet process leadless cast iron enamels. Owing to the restrictions on lead enamels, British experts have had to spend a great deal more time on research work, both on the enamel and in the foundries.

Absence of Girl Labour

A further interesting point relating to the enamelling shops in America was that in almost every case male labour was employed, and only on a very few operations were girls employed. It was understood that the average female earned 44 cents per hour (about 1s. 10d.) and the male labour from 50 to 58 cents (about 2s. 1d. to 2s. 5d.). It should, however, be remembered that the cost of living in the States is almost double that in England. Below are detailed impressions of the individual plants visited.

Baltimore Enamel & Novelty Company

This firm produce signs and sheet iron jobbing work. They have one "U" type continuous oil-fired furnace and four 10 ft. by 4 ft. box-type oil-fired muffles. They manufacture their own frit and use fixed smelters. The smelting plant is by no means elaborate. No dust precautions are taken, and the raw materials are mixed by hand on the floor of the department, and the enamel leaving the smelter is quenched in an enamelled bath.

The continuous furnace operates at 840 deg. C. and grip, white and other cover coats are

* A Paper read before the Northern Section of the Institute of Vitreous Enamellers.

fired at this temperature, although it was understood that a harder grip is used for the enamelling of signs. This furnace is capable of producing 2,000 sq. ft. of one coat fused ware per hour, and requires from seven to ten operators. It consumes 60 gallons of oil per hour at a cost of 2½d. per gallon.

The sprayed or dipped ware is dried in the first zone of the continuous furnace. The heating of this zone is effected by heat radiation from the fused work coming out of the furnace. The grip coat dipping is by hand, and after dipping the sheets are hung at an angle on a conveyor which passes over three troughs into which all surplus enamel drains from the sheets. The conveyor containing these grip-coated sheets passes through a tunnel type gas-fired drier. Any black edge at this plant is sprayed on to the fused grip.

One method of edging is to scratch the enamel at the width required and rub off the surplus enamel from the edge with a wire ball similar to those used by housewives in this country for cleaning purposes. This, as a personal opinion, was not very good practice, owing to the fact that ragged edges could possibly result.

With the batch type furnaces most of the sheet iron ware is suspended. The loads are blown off by means of a drilled tube fitted to the bottom of the furnace door, which when opened for the inserting of a load automatically turns on a valve, and air is blown over all the sheets entering the furnace. The air is turned off when the load is being withdrawn.

Porcelain Enamel and Manufacturing Company

This plant contains two rotary smelters and one box-type smelter and two continuous-type smelters. The continuous furnaces were used more than the other types. As the continuous smelters were railed off the visitors were not able to see exactly how the raw materials were loaded. The smelted enamel trickles in a thin stream out of the front of the smelter into a water well. Running through this water well is a bucket elevator, each bucket holding approximately 10 lbs. of frit. These are carried round to the top of the smelters, where a trip tips the buckets and the frit is delivered into a rotary frit drier, which is gas heated. In this drier frit dust is also extracted.

From the drier, the frit is carried through to a hopper, weighed off in 100-lb. lots and bagged in separate bags which are passed to a stitching machine for sealing. All raw materials in this plant are rotary mixed. This plant has a laboratory for testing smelts, for colour-matching, and for the general control of frits. It is interesting to note that at this plant, as at other frit manufacturers' plants, there is a stream of running cold water at the spout of the kiln. This water runs down the spout with the frit when it is being emptied, consequently giving it an earlier quenching.

Enamelled Houses at Pittsburgh

On arriving in Pittsburgh, before going to the plant of the Carnegie Illinois Steel Company, the visitors were taken to a housing scheme where 300 enamelled houses were being built for employees of the Steel Company, and which were to be sold at approximately £750 each. It is interesting to note that these houses were built chiefly of steel and asbestos. No skilled workmen were employed in the building of these houses, which were put together more in the way of a portable garage. In other words, all the steel, asbestos, and what little timber had been used, had been cut to size and drilled before being sent on to the site. In the opinion of those members of the party who saw them, they considered a similar house in this country would not sell very well.

All the steel on the exterior was enamelled in various colour schemes, and the enamelling generally was of a good standard, particularly that in the bathroom where a Briggs steel bath and sink were fitted. The walls of the bathroom are lined with enamelled steel sheets. The kitchen contains an enamelled refrigerator, cooker, and Briggs sink, all of which are steel. The walls of this room were also lined with enamelled steel panels.

Carnegie Steel Works

Visitors then went to the steel works, stated to be one of the largest plants in the world. They produce steel girders of all types, but as the general principle of production is similar to that of the Armco plant, which produces steel sheets, a general description will be given later, when describing the latter concern.

Ingram-Richardson of Beaver Falls

This firm enamels signs, table tops and general architectural work, and incidentally they were responsible for the architectural work on the houses mentioned earlier. They, like the Baltimore Enamel & Novelty Company, have their own press shop, which is a very elaborate affair, containing some very fine presses. Here, again, they manufacture their own frit. Mr. Ingram, sen., is an Englishman, hailing from Birmingham.

All raw materials are rotary mixed at this plant. They have four gas-fired box smelters, each having three burners. About 950 B.T.U. gas is used at a cost of 1s. 8d. per 1,000 cub. ft. Each smelter has a capacity of approximately 1,000 lbs. of raw materials. Two of these smelters were in use at the time of the visit. They also have a rotary smelter for sheet iron grip coat.

The enamelling plant contains one large elevated "U" type continuous furnace, one small straight-through continuous furnace, and three stationary furnaces. The drying zone on the large continuous furnace is 80 ft. long, and the fusing zone 35 ft. long. All cover coat is fused at 825 deg. C. and the grip coat at 855 deg. C., all grip being fused on the night shift. The large continuous furnace is heated by both gas and supplementary electricity. This is a recent introduction on their part. Originally it was an electric furnace, but gas had been introduced by means of tube heating, and so far this has reduced fuel costs, and was, it was stated, quite successful.

The grip coat is all dipped by hand and drained as in Britain, but after draining is hung on a conveyor, where it passes through a gas-fired tunnel-type drier. They also have a spraying machine installed at this plant. Male labour is employed for the brushing of signs, the stencil brushes used being connected by means of a flexible tube to an exhaust ducting. These operators are very fast, and no dust whatever was visible around the brushing tables. This firm also produce very fine finishes on signs and table tops by the silk screen process. It certainly is very intricate work, and the finishes obtained are without doubt of a very high standard.

They also have in use a graining machine for reproducing all types of wood grains, and this was used chiefly for table tops and architectural work. This was, speaking personally, one of the best plants visited. Whilst there were girls operating the small silk screen process, the majority of the workers in the plant were male.

The Armco Works

From here the party flew to Dayton to visit the Armco plant at Middletown. This is a tremendous plant, and everybody was amazed at the cleanliness throughout. The pig-iron is brought in molten form from the blast furnaces, which are twelve miles away, in large steel refractory brick-lined carriers, by rail, where they are emptied into open hearth furnaces, fired with gas or oil. This is rather interesting, for, although they prefer gas, if they had for any reason to change over to oil, they could do so without delay.

Each of the eight open hearth furnaces contains 150 tons of metal, which is brought up to a temperature of 1,465 deg. C. Dolomite or magnesite is added with the melt to assist fluxing impurities from the iron.

From these furnaces the molten metal is poured into 15-ton capacity ladles. The steel is bottom poured from these ladles into moulds, and, when set sufficiently for handling, the ingot is withdrawn and transferred into soaking pits. Each ingot weighs six tons and each of the soaking pits holds four or six ingots. Here they are reheated to a temperature of 1,300 deg. C., and are then transferred to the first rolling mill, then to a reheating furnace, and finally through further mills.

It was interesting to observe that, when the sheets came down to a certain temperature, known as the critical point, no rolling could take place, otherwise the sheets would splinter or buckle.

All rolls on the mills are water-cooled and high pressure steam is blown on to the sheets for removing scale. Scale collected on the end of the rolled sheet is sheared off at a later period. All gas used is 950 B.T.U. gas and is purchased at 1s. 10½d. per 1,000 cub. ft. When the sheets are reduced to a certain thickness, they are sheared in sections and then rolled out to a thinner gauge. They are then "sewn" or welded together for passing through a continuous pickling plant, after which they are cold-rolled. For hot rolling, however, they are cut into lengths of approximately 14 ft. There was also a galvanising plant working here which was of general interest.

The research laboratories are housed in a building made almost entirely in steel, even down to the slats of the Venetian blinds. The exterior of the building was completely enamelled, the colour scheme being cream and black, and certainly looked very attractive. The research department at the Armco plant contains a laboratory for every industry in which their steel is used, and quite a large section is set aside for research work on enamelling. They have a small, yet complete, enamelling plant, and four chemists working continually in this plant, where a very considerable amount of useful data has been compiled, and the impression was gained that they were concentrating more seriously on research for enamelling on steel than any other one concern visited.

Porcelain Enamel Institute Forum (Urbana)

This Conference lasted all day Thursday and Friday, during which time Papers were constantly being read, most of them being heard by the British party. The visitors also toured the Ceramic House, which is part of the University Buildings, where students are trained for all sections of the industry; pottery, vitreous enamelling, brick-making, the manufacture of oxides and so on. This again is a fine building, and contains a very large number of laboratories and small workshops. This is a similar organisation to our own at Stoke-on-Trent. The party was interested in small pieces of enamelled iron set in Leucite, which, after polishing, were viewed under a microscope, where it was possible clearly to see the iron, grip coat and white cover coats. It was shown how the fusing of the grip had allowed iron oxide from the sheet to penetrate the grip itself and ensure a good adhesion to the metal.

Chicago Vitreous Enamel Company

On Saturday morning, October 15, the party visited the plant of Chicago Vitreous Enamel Company, which does not normally work on a Saturday, but had been kept going specially for this occasion. It is even larger than the Pemco plant. This plant contained a number of laboratories which were all enamelled in different colour schemes, and whilst it was very showy, it was certainly impressive.

They have three continuous smelters and one box-type smelter. Raw materials are mechanically mixed in rotary mixers, the drying, sieving and magnetic separation being similar to that

already described. They also have an automatic weigher for the bagging of the frit and a stitching machine for sealing the bags.

Ferro Enamel Products

The next plant visited was on Monday, October 17, and was that of Ferro Enamel Products, who manufacture frits and pottery glazes. This plant did not exhibit quite the showmanship of certain of the others, and consisted of a number of box-type smelters, each having a capacity of about 2,000 lbs. of raw materials. They also have three continuous smelters. It was stated that they have their own felspar mines, and in any case the felspar is delivered to their plant in the natural state, crushed in their own mills and prepared in every way for their own requirements.

Apart from the gas used, they consume 7,000 gallons of oil per day. They stock 3,000 tons of frit and pottery glazes, and could produce 30,000 tons per year. A travelling truck runs beneath all the hoppers containing the raw materials, where the required amount was automatically weighed out until the batch was completed.

All raw materials are rotary-mixed, emptied on to conveyors and carried to a floor above the smelters, where they are handled by means of trucks and a travelling crane to the respective smelters. After smelting and quenching, the frit is dried in the manner described in connection with a previous frit plant. It then passes along a rubber coated conveyor, where it was picked whilst in motion. The rubber on the conveyor for black frits was black, and for the opaque frits it was white. After this it passed over a magnetic separator and on to the bagging section. They also have laboratories for the control of frits and glazes.

In this plant there is an interesting piece of equipment, known as a Weatherometer. With this instrument it is possible to place a piece of porcelain enamelled casting or sheet into it, and by means of various electrical devices it undergoes in a fortnight the equivalent of twelve months' exposure under normal climatic conditions.

Enamel Products Company

Whilst in Cleveland we also visited the plant of Enamelled Products, who are one of the largest manufacturers of enamelled table tops in America. They also process a considerable amount of architectural work. The plant consists of two continuous furnaces, one "U" type and a counter flow type, both being electrically heated. Most table tops are enamelled both sides. This appears to be generally requested by purchasers of table tops.

Nearly all signs being processed are hung in the furnace. The perrets are of a special design to enable them to hang the table tops and at the same time keeping them straight. They have a continuous drier and the brushers-off here use the exhaust stencil brushes mentioned earlier. There is also a certain amount of silk screen work processed here, and a spraying machine is also installed. In this plant the sprayers were female, and all large sheets were sprayed whilst hanging in the booth.

Briggs Manufacturing Company

The last plant visited was that of Briggs Manufacturing Company, in Detroit. Two oil-fired furnaces, each approximately 15 ft. by 5 ft., were installed, with double fork charging machines. Their average production is 300 baths per day, and they fire four baths per load. The grip coat is fired at 855 deg. C. for eight minutes and cover coat at 825 deg. C. They employ about 75 operators, working three shifts, and have an enamel shop superintendent and one or two chemists. All baths are of 14-gauge metal.

Their grinding mill capacity consists of:—Three 1,200 lb. mills, two 500 lb., two 150 lb., and one 300 lb. mill. All baths are pickled prior to metal finishing, by which is meant that all baths are pickled as though they were to be enamelled and then are conveyed to a large shop, where a number of men are employed polishing the baths with buffs, filing where necessary, and welding on lugs for the attachment of feet or side panels, etc.

From here they are conveyed to another pickling room, prior to enamelling. In this department a nickel bath is included. It was interesting to learn that the nickel bath enabled them to fire the grip coat 10 deg. C. lower than had been necessary before the installation of this tank. It was stated that it had also reduced the tendency for fishscaling and copper-heading, and also gave the grip a much better adhesion to the metal. In each pickling room hot sulphuric acid is used. All baths are conveyed through the plant on chain conveyors.

In the spraying section three men are employed on one bath for applying grip coat. For the first cover coat one man is employed inspecting the grip and two spraying, but the first man, after inspecting, also sprays a small amount of enamel containing gum arabic in the corners of the bath. This, it was stated, was done to eliminate hairlining. The bath, when finished, has received one coat of grip, which is fired, one cover coat also fired, and another cover coat which, before drying or fusing, is covered again with a very thin coat of acid-resisting enamel.

It was also stated that about 20 per cent. had to receive another coat because they were marked during processing. In that case, the whole bath had to be sprayed over again, otherwise the portion which was not sprayed would go dull on the second firing. The final rejects, it was stated, were of the order of 1½ per cent., and these were stripped by means of sandblasting. The grip coat scrapings are used for the covering of the outside of the bath, and all cover coat scrapings are scrapped. It was interesting to note that this was the only firm visited which did not make its own frits. For the nickel bath, mentioned earlier, 4 ozs. of nickel salts are added per gallon of water and also ¼ oz. of boric acid per gallon. The solution is heated to a temperature of 170 deg. Fah. (just below boiling point).

The baths are produced in twelve different finishes, and the average bath sells to the merchant at approximately $30 to $36 (£6 to £7). A larger plant, it is understood, is being built, incorporating a continuous furnace. The stationary furnaces in use at this plant are of the under-fired type, and were stated to be a very satisfactory type of furnace, as it gives them the requisite amount of bottom heat. Perrets of a special design are used for supporting the baths in the furnace, and whilst these were considered quite satisfactory, a considerable amount of experimental work had to be done before they found the most satisfactory type.

The spray booths are really complete rooms, 30 ft. long by 20 ft. wide. A considerable amount of exhaust ducting was installed around where the baths were being sprayed for exhausting the enamel dust, and at the same time fresh air was being blown into the plant. As can be expected, the operators are badly covered with enamel, and each of them wears a respirator.

The information was given that it had been a very hard job to train the sprayers and other operators. The plant has been in operation four years. Before concluding, the author would again stress that his remarks have been confined to the plants visited.

The engineering and gear-cutting activities of Henry Wallwork & Company (1920), Limited, Manchester, have been acquired by Wallwork Gears, Limited, whose registered office is at the same address. The management is virtually unchanged, but to cope with the growing requirements of the business, additional plant is being installed and further working capital provided.

Further Observations on Scientific Aids to Control in Vitreous Enamelling

Mr. G. H. Abbott's remarks published in the Journal of March 2, on page 199, suffered from inaccurate reporting, and the following points require amendation.

(1) In the report of the London meeting referred to (*F.T.J.*, February 2, p. 124), his remarks on thickness measurements made at National Enamels, Limited, are attributed to Mr. J. Barry.

(2) No reference was made by Mr. Abbott to any measurements quoted recently by the German technical Press. In his Paper to the Institute (*F.T.J.*, October, 1934), Mr. England had referred to Dr. Hovestadt's book dealing with the physical properties of Jena glass. This book was published 40 years ago.

(3) The phrase "the co-efficiencies of frit, shot abrasive, etc.," should read:—"It would be interesting to hear about measurements of the expansion coefficients, elasticity moduli and mechanical strengths of enamel frits. A frit with a low elasticity modulus would probably give a *good* impact value."

(4) The elutriation method for testing the fineness of enamels is used at National Enamels, Limited. From experience of the screen test, results are not reproducible due to irregular sintering of the residue during drying.

(5) No figures were given by Mr. Abbott for enamel thickness on cast iron.

Books on Enamelling

Mr. B. B. Kent, of Sterling Manufacturing Company, Davis Street, Cubitt Town, London, E.14, informs us that on behalf of the Institute of Vitreous Enamellers he carries stocks for disposal of the following books:—

"Enamels: The Preparation and Application of Vitreous Enamel," by A. I. Andrew, B.Sc., M.S., Ph.D. 25s.

"A Manual of Porcelain Enamelling." 25s.

"Handbook on Design of Metal Parts in Porcelain Enamelling." 1s.

"Test of Acid Resistance of Porcelain Enamel." 1s.

"Test for Resistance of Porcelain Enamels to Surface Abrasion." 1s.

"Production of Castings for Porcelain Enamelling." 1s.

"Recommended Materials and Practice for Architectural Porcelain Enamel." 2s.

Application for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"Donite." — Castings. Guest & Chrimes, Limited, Don Street, Rotherham.

"Colbond."—Colloidal clay for foundry use. Cloyne Clay Company, Limited, c/o Marks & Clerk, 57/58, Lincoln's Inn Fields, London, W.C.2.

A New House Organ

Under the title "One Hundred and Eleven," the Hammond Lane Foundry Company, Limited, and its associated concerns, have issued the first number of a quarterly staff magazine. The reason for the choice of the title is the number on the company's premises in Pearse Street, Dublin. This foundry, which was established in 1902, is now the largest in Eire, employs over 800 workers, and melts about 40 tons of metal a day. The magazine is of the type which caters primarily for the staff and does not utilise its pages for advertising its own goods. For a first issue it is rather ambitious and runs to 64 pages. Its character is generally light, and it contains a number of cartoons and humorous stories. We wish the new venture every success.

Technical Problems in Vitreous Enamelling

OPEN DISCUSSION IN BIRMINGHAM

A recent meeting of the Midland Section of the Institute of Vitreous Enamellers was devoted to the discussion of technical problems. Mr. W. Todd presided.

Enamel Consistency and Spraying Pressure

Mr. J. H. Gray raised the first question, as to what was the best consistency of enamel for use with cast iron and sheet iron in relation to the spraying pressure. He had seen several plants using enamels heavier than others, and using 40 lbs. pressure whilst the others used 60 to 80 lbs. He wished to know whether anyone present had found that a higher or lower pressure suited them in obtaining work free from orange peel, etc. Mr. Gray had found that in most shops, irrespective of whether they were buyers or manufacturers of enamel, although the specific gravity of the enamels remained the same, by taking daily tests, the consistency varied. This, he felt, was why people could not keep a consistent spraying pressure. Also, the type of ware being sprayed must be taken into consideration as well as the type of enamel and the gun used. He found that a good average was 40 lbs. pressure for sheet iron and 60 lbs. for cast iron, the cast-iron enamel having a higher specific gravity. This practice definitely gave better results than a thin enamel used at lower pressures. The average specific gravity of cast iron was 1.9 and of sheet iron 1.6.

Mr. Hallsworth considered that many items in the enamelling processes depended, more or less, on the enameller's experience, which made it so difficult to establish specifications and standards. One man preferred to spray at 60 lbs. pressure and increased viscosity, whereas others preferred a coarse enamel, and to use that coarse enamel increased the pressure accordingly. In his experience he had obtained much better results by spraying cast iron at a pressure of 50 lbs. with varying enamels, at a specific gravity of 1.85. The chief trouble with spraying at a high pressure, he had found, had always been the blowing-off of the enamel on any sharp edges of the castings. He had never been able to cover the edges so well at 60 lbs. pressure as at 40 lbs. Then it more or less fell on to the ware instead of being blown on. This applied mainly to enamels which had not been artificially set-up.

The Chairman (Mr. W. Todd) said that it might vary according to the distance of the gun from the ware. If the enamel was blown off the edges the gun was being held too close, and there was naturally a tendency to produce a rippled or "orange-peel" effect.

Case of Cast Iron

Mr. S. W. Barkhouse said that, in his experience of spraying cast-iron enamels, he found that the higher the viscosity of the enamel the better the results. His firm used 80 lbs. pressure and, he thought, sprayed at a higher speed than anyone else in the trade. Cast-iron enamels were used fairly thick, especially acid-proof enamels, with a view to getting plenty of enamel on the casting; this, in his opinion, helped to avoid boiling and blistering. They had to use 80-lb. pressure with such thick enamel in order to get it through the spray guns, and there was no trouble with enamel blowing off the edges by reason of the thickness. On sheet iron, 60 lbs. pressure was used, primarily for speed; this caused a large amount of enamel to be continually deposited in the spray booths, but the loss of enamel was considered to be more than offset by the speed in production.

Mr. S. W. Vickery considered that possibly one of the reasons why enamellers tried to keep the specific gravity of enamels quite high, especially for direct application, was the attempt to spray the enamels in a comparatively dry state. His theory was that some of the water in the enamel would be lost between the gun and the ware. By using a wet enamel at a low pressure more of the water would be retained in the enamel and so soak into the casting. Therefore, the higher the specific gravity the more pressure would be used. All specific gravities and pressures should be judged according to the type of gun being used.

Differences in Practice

Mr. S. Hallsworth asked why Mr. Gray thought sheet iron should be sprayed at a lower pressure than cast iron.

Mr. J. H. Gray thought it was due to the fact that one was dealing with entirely different forms of ware. While some stampings were very intricate they could not be compared with some of the castings which were enamelled, having very deep crevices and heavy lugs, etc. Furthermore, with sheet iron more flat areas had to be enamelled and if the high pressure was used there was a tendency for orange peeling.

The Chairman remarked that on round or radiused corners there would be a tendency for the enamel to run back from the edges.

Mr. Gray said that at one time, when a casting was sprayed and in the wet state, it looked from a distance like a fused casting. Now there was a tendency to use a thicker enamel and get a dry appearance on the surface of the casting.

American and Lancashire Practice

Mr. A. G. Read considered that to spray successfully enamel at a high pressure it had to be ground fairly coarse. If the enamel were ground finely, it could not be sprayed at 80 lbs. pressure without trouble. The current tendency in America was to grind the enamel very finely, using one coat enamel on sheet iron, but this could not be applied at 80 lbs. pressure. They had to use 35 lbs. pressure to get a decent job. He knew of a Lancashire firm who enamelled mangles back and front. They used enamel at a higher viscosity and ground more coarsely than he had ever seen elsewhere, spraying at 80 lbs. pressure and getting a really good job. The firm had been trying for years to use more finely ground enamel and less pressure, but as soon as they varied the method they had trouble.

Mr. Barkhouse suggested that the firm, if they wanted to grind their enamel finely, should scrap their alkali frits and concentrate upon acid-proof frits.

Mr. Read suggested that he had never tried this on a double-sided mangle.

Mr. Massey suggested that the fineness of the grinding might not have been kept uniform. He thought much depended on the spraying equipment used. He mentioned the small shop enamelling signs, washing machines, refrigerators, etc., which had just one compressor, and would not go to the trouble of fitting a reducing valve, although they had to use 80 lbs. pressure for the shotblast and for the spraying pressure. They might be doing refrigerator enamels and milling to approximately 13 grams on a 200-mesh screen and turning out good work. When it came to doing signs and using red or finer coloured enamels, they milled down to no residue on a 300-mesh screen. If 80 lbs. pressure had to be used constantly, then a reduced orifice could be fitted in the spray gun.

BLISTERING ON HEAVY SECTIONS

Mr. Barkhouse then raised the query: why should there be blistering and boiling on heavy sections of cast iron, especially when recoating?

Mr. Hallsworth thought that this was connected with the porosity of the cast iron. The thicker the section, the more porous the metal; where the iron was coarse-grained, there was more chance of oxidation. There were more included gases in these sections and more chance of reaction taking place, with oxidation of the graphite flakes to cause boiling when enamelled. If a heavy section and a light section of a casting were subjected to microscopic examination, the difference in the two sections would be revealed.

The Chairman said that boiling was experienced on the first coat of heavy sections.

Mr. Barkhouse stated that on a white coating they could get a perfect first coat, and it was noticeable with some enamellers that they did white in one coat, whereas when jobs were coated a second time they were of inferior appearance. He personally had one or two theories, but wished to hear the theory of someone who knew more about cast iron than he did.

Thermal Equilibrium and Boiling

Mr. J. Whitehouse thought that perhaps the annealing temperature was above the critical point of the iron. The percentage of carbon should also be taken into consideration. It had been found that even with the combined carbon down to 0.2 per cent., it was possible for boiling to take place, if the temperature reached in the enamelling furnace was above the first critical temperature of the iron (700 deg. in the case of Swedish iron). Sometimes the critical temperature of the iron varied considerably. Another case of boiling was probably due to oxidation of the graphite flakes. That might take place if the castings had been annealed first, because if the annealing temperature brought out the graphite flakes, it was possible for the iron to oxidise, and this reacted again when the casting was enamelled. He asked why this should not happen in the first coat.

Mr. Hallsworth replied that it did happen.

The Chairman said that, assuming the castings were not annealed initially, it might be in the first fusing that a physical change took place, which reacted on the second coat. That was the reason why it occurred on the second coat and not the first. It was difficult to reconcile that with the fact that it occurred when the castings were annealed. His firm annealed all castings, irrespective of type of finish, and boiling had occurred on first and second coats, which was very confusing.

Mr. J. H. Gray said that his firm had recently been enamelling some Swedish castings and had found that they were the best enamelling iron he had ever handled. The ware was coated with acid-resisting enamel inside, and one coat of soft enamel outside with a different coloured handle. Therefore, the inside acid-resisting enamel had two firings with only one coat, and there was no sign of blistering with the temperature at 750 deg.

Mr. Massey made reference to one-coat enamelled cast iron and suggested that the spraying for one coat would be applied much heavier than on the two-coat job. When it came to fusing the casting, perhaps the enamel was not cooked all the way through to the iron, so that when fused a second time it boiled.

Fusing Times

Mr. J. Whitehouse, after ascertaining that the temperature of the furnace was checked pyrometrically, asked if the castings were in it for a sufficient time to ensure the heat permeating throughout the mass. He was told 15 min. was a recognised time.

Mr. J. H. Gray said that if the furnace reached a temperature of 740 to 750 deg. C., the reading depended upon the position of the thermocouple in the furnace. One should regard that as a check, and not as the true temperature. If the casting was in the furnace for 15 to 20 min., the temperature of the casting would be the same as that of the furnace.

Mr. J. Whitehouse thought that in the immediate vicinity of the casting it might not be so.

He questioned whether 15 min. was a sufficient time for the heat to permeate the castings completely.

Mr. Barkhouse said that the castings were left in until they were the same colour as the furnace, and then the fuser, watching through the peep-hole, brought them out.

Time Intervals

The Chairman said that most enamellers reckoned to get about three loads an hour from the average muffle, fusing flat loads.

Mr. Barkhouse pointed out that this was not possible in a plant where all kinds of ware were processed, including heavy castings from ¾ in. to $\frac{7}{8}$ in. thick.

The Chairman replied that one would not put in mixed loads, and suggested that work could easily be arranged in order to fuse loads of similar section.

Mr. Massey said that the ratio of difference for different weights of castings was negligible. If the poundage was doubled, then the length of time in the furnace would be doubled.

Design and Boiling

Mr. J. W. Price said that, as a jobbing enameller, he often found a heavy section would come out satisfactorily, and another casting would often boil on a lug section at the same spot, yet it might be only ⅜ in. thick. This suggested that the design of the casting was all-important, particularly in regard to sharp corners. Sometimes the sand in the mould was carried off the sharp corners to some other place and held there, thus giving undesirable inclusions. Recently he had seen a job with lugs inside about 2 in. thick; it was an urgent job for one coat, and had to be good. Much to his surprise, it had turned out very satisfactorily. He did admit that, on recoating, they did not get very good results with most direct work.

Disposal of Charge in Furnace

Mr. Gray said that for some time he had held the opinion that by double-decking or hanging cast-iron work in the furnace, taking 30 to 35 min. to fuse (an average of two loads per hour), better results were obtained on soft or acid-resisting enamels than by single-deck loads. In his opinion, the best method of charging a furnace for cast iron was to hang on one side and double-deck on the other side. More work was put through the furnace per hour, and this could be worked on alternate loads. Multiple loads could not be used unless the height of the furnace was increased. Some work was better if hung instead of being flat, as there was a slight movement of the enamel in the molten state.

Mr. Hallsworth was in sympathy with this suggestion from a cost point of view. But if Mr. Gray had a special sample to do, would he put it on a double-deck or a single fork?

Mr. Gray replied that he would put it on a single fork, as it could be watched more closely without lowering the temperature of the furnace. He also observed that a long slow temperature gave better results than quick "snappy" firing.

The Chairman suggested that preheating was more important in the case of heavy loads.

Mr. Hallsworth agreed with Mr. Gray if the castings were all of the same thickness, weight and size.

Mr. Gray disagreed. He mentioned firing a load of doors with heavy lugs. In almost every case where single decking was applied they had to be withdrawn and be cooled off somewhat before returning into the furnace, whereas with heavier loads this was unnecessary.

Mr. Vickery said that there was a difference in the ware and in the furnace itself. If the furnace temperature was reduced sufficiently and the castings heated up slowly, the heat would penetrate into the thicker sections as well. It was just possible that, when the load was introduced, the side walls were very hot and it was apt to scorch the enamel on the thinner sections.

A Member asked how far the rate of cooling would affect a casting $\frac{3}{16}$ in. thick with lugs ½ in. to ⅝ in. thick.

The Chairman replied that the rate of cooling, after drawing from the furnace, must affect the "sealing" of the enamel which took place before the included gases had finished exuding, and therefore it followed that the "sealing" of the thin section was complete before the area immediately covered by the heavy lugs. This resulted in boiling. Alternatively, on occasions it was found that the metal "draws" or "sinks," leaving a marked depression on the surface of the iron.

Mr. Read mentioned a well-known solid-fuel-fired slow-combustion cooker, which carried a matt ground-coat. The loads, he said, averaged two per hour, and this work had been going on for a number of years, yet he did not remember ever seeing a load taken out and put back again. Also, he did not think there were any castings used anywhere with such a variety of thick and thin sections. The doors had two very heavy lugs and these were packed closely together on the load, but they never had to be put back again and there was very little boiling.

Crawling of Hanging Loads

Mr. Barkhouse asked if enamellers ever experienced a tendency for enamel to crawl on hanging loads.

Mr. Hallsworth said this was not so if the ware was sprayed correctly.

Mr. Barkhouse said that although one could fire a load on the flat successfully, the same spraying and enamel on a hanging load would produce fine crazing and crawling.

Mr. Hallsworth recommended him to try spraying at 40 lbs. pressure and triple decking. He said that probably the spraying was uneven and they relied on the furnace to overcome the crawling tendency by giving the enamel a sharp fire, but when hung the crawling took place. He had experienced very little crawling, even with triple decking, when spraying at a lower pressure.

Mr. Barkhouse thought maybe the wider mottle helped matters. He had not experienced crawling in self colour.

Mr. Todd said that crawling was usually due to bad spraying, and this was often traced to a new operator.

Mr. Gray had not known crawling to be due to high spraying pressure, but it did occur when the enamel was damp.

Graphitic Structure and Moisture

Mr. Barkhouse referred to Mr. Hallsworth's statement that on the heavy sections graphite flakes were much coarser than on the thin sections. Might it not be that the moisture from the second coat permeated more into the cast iron than it did where graphite flakes were much finer?

Mr. Gray said that the first-coat enamel was now absorbent.

Mr. Barkhouse said that after enamelling castings back and front, they had drilled a small hole in them and fused again, hanging them in the furnace, but still got boiling and blistering in the heavy sections. They were now, therefore, at the stage when they relied upon having some assistance from the more technical men in The Institute of Vitreous Enamellers and the Institute of British Foundrymen as to the reaction that took place on the second-coat fusing enamel on cast iron.

Mr. Whitehouse remarked that so many factors might cause blistering and boiling that it was impossible to put one's finger on one particular item. Personally, he thought that the enamelling temperature played a big part, and if the critical temperature of the iron were exceeded there was hardly anything that could stop it from boiling. Unless there was a definite temperature, and the constitution of the iron in question was known, it was practically impossible to form any theory as to what had happened and whether the temperature was above the critical temperature. Even if the temperature of the enamelling furnace was not above the critical temperature of the iron, many things have to be taken into consideration.

Reprocessing

Mr. Barkhouse said that if a casting was reprocessed and fired up right away on the second coat, there was a much better chance of avoiding the boiling than if the casting was left for a length of time. The quicker castings were reprocessed and fired, the better chance there was of having good results.

Mr. Whitehouse's theory was that if a casting was sprayed and allowed to stand, there might possibly be a formation of oxide due to the presence of moisture.

Mr. Hallsworth did not consider the composition of the iron was the cause of this specific trouble, but rather porosity and inclusions.

Mr. Whitehouse interposed that he assumed the castings in question to be perfectly enamelled.

Mr. Hallsworth replied that boiling always occurred over thick lugs, not where the section was even. The difficulty was to overcome this and produce perfect castings.

The Chairman said that it was the duty of the ironfounder to produce castings fit for enamelling; even if a casting was superficially perfect after shot-blasting, boiling might occur during the enamelling process.

COAL DUST IN FOUNDRY SAND

Mr. Whitehouse asked the enamellers' opinion of the use of coal-dust in the foundry sand.

Mr. Barkhouse suggested that castings which had a good skin on them had probably 10 per cent. coal-dust in the facing sand. Where the facing sand was burnt into the casting there would be trouble, unless the top surface was "scurfed," and providing the casting was sound underneath. Annealing and shot-blasting did not remove the burnt-in sand. Scurfing alone would correct the trouble.

Mr. Massey suggested that the perfect casting, from the enameller's standpoint, should be free from any carbonaceous matter.

The Chairman, speaking from the foundryman's point of view, said that in certain instances castings could not be made without the use of facing sand, but one could not dogmatise.

Moisture Absorption

Mr. Hallsworth, going back to the question of re-coating, said that in the absence of anything to the contrary, one had to accept Mr. Barkhouse's theory that the enamel absorbed moisture if left about the shop for 24 hours, particularly with acid-proof enamel, and boiling would then be experienced. The castings or first-coat enamel must absorb moisture which boiled through the second-coat enamel.

The Chairman said that in his own enamel shop all ware was fused on Saturday and not left in the "biscuit" stage over the week-end.

Mr. Price mentioned a remark of Mr. Read's: "Never let it get cold." He considered this was a good policy to pursue with direct two-coat cast-iron work.

NECESSITY FOR PICKLING

Mr. Read said there was a new quantity-production sheet mill in commission in South Wales which rolled sheet for enamelling. Would it be necessary to pickle the product?

Mr. Vickery said that this would be essential. He recalled the introduction of the crystal etched enamelling iron, the surface of which was as white as a sheet of paper and no dirt was to be seen upon it but on receipt, no matter how the sheets were stored in the warehouse, the surface held moisture easier than C.R.C.A. sheet, and the iron rusted much more quickly than ordinary stock; therefore, it needed pickling. He had first esteemed it to be perfect, and had tried to enamel it without pickling, but did not get nearly such good results as formerly.

USE BRITISH ENAMELS

BY using British Made enamels you bring about the regular and direct employment of your fellow countrymen. You help to relieve the burden of taxation and to increase the growing prosperity of this land. Expansion of trade in British Enamels brings benefit to all classes of industry; from those who supply the raw materials to those who design the machinery which transforms them into the finished product.

Buy British Enamels, and to be sure that you get the best – Buy Blythe.

Blythe ENAMELS

Blythe Enamels are consistent – they do not vary from batch to batch. They represent the finest value in enamels that you can obtain the world over and they are British throughout.

BRITISH MATERIALS, LABOUR & MANUFACTURE.

BLYTHE COLOUR WORKS Ltd.

CRESSWELL, STOKE-ON-TRENT.

MR. GRAY referred to the recent trip to America. On going through some of the plants he had seen sheets that certainly did not appear to require pickling.

MR. READ mentioned that a new type of hollow-ware plant was to be erected in this country, and he understood that pickling was to be eliminated. When the ware came from the machine shop it would be sprayed with hot alkali and washed, not pickled.

MR. HALLSWORTH suggested that the vagaries of the British climate had been forgotten, for oxidation would take place on the sheet in transit between the plant in question and the steelworks.

MR. READ said that the two firms were next door to each other, so that the arrangement might be satisfactory.

The CHAIRMAN thought that they would not be able to take the sheet straight from the mill to the press shop.

MR. READ mentioned that after it left the press shop it would be washed in alkali.

USE OF NICKEL DIP

MR. GRAY said that during an inspection of a plant in Detroit, the chemist told him the happiest day of his life was when he installed a nickel dip in his pickling shop, because he had definitely not seen any fishscaling since, and a much thinner grip coating could be applied. Moreover, the adhesion to the metal was much better. The fusing temperature of the grip coat was 30 deg. lower since the nickel dip had been included in the pickling room.

MR. MASSEY pointed out that the metal had to be prepared before it would take the nickel dip, and should be perfectly clean before the acid treatment, *i.e.*, free from oil and grease, because nickelled ware could not be re-pickled.

MR. HALLSWORTH agreed that the use of a nickel dip would improve the enamelling but could not be justified by reason of increased costs. It would be satisfactory if it eliminated the grip coat.

MR. GRAY said that the melting point of grip-coat frit was 740 to 760 deg., and asked why it was necessary to fuse at 860 or even 900 deg.? If particles of grip coat were ground down and put on a slab with a quantity of white frit, and they were fused, they would both come down together. Then why fuse one at so much higher a temperature than the others in practice?

MR. VICKERY referred to fusing the enamel in a ground coat at 730 deg. He said that one had to fuse at a high temperature to form an oxide film which was necessary to get the adherence.

MR. HALLSWORTH said that the lower fusing of grip coat did definitely affect the adherence.

MR. GRAY asked if there really was any advantage in adopting a white grip coat. If a black edge was required, it was necessary to apply the black enamel, whereas with a cobalt grip coat, it was quite possible to use the grip coat as a black edge.

New American Process

MR. MASSEY said that in recent months another process had been evolved in the U.S.A., where certain enamellers were doing away with the grip coat and applying the colour direct to the metal. Unfortunately, there had to be an extra tank in the pickle "line-up," *i.e.*, the cobalt dip. After the steel passed through the pickling process in the regular fashion, it was dipped into the cobalt tank. It was put in the annealing furnace at approximately 615 deg. C. and the cover coat was then applied. The sample he had seen was exceptionally good. He did not know whether the process, which was called the "Hommilyea" process, was a commercial proposition.

MR. READ mentioned that in the early days all the ground coats were white.

The CHAIRMAN closed the meeting by saying that they had had a very profitable and useful evening, covering a fair amount of ground.

Thermal Insulating Materials

POINTS FROM A.S.T.M. SYMPOSSIUM

During the Regional Meeting of the American Society for Testing Materials, in Columbus, Ohio, last month, a symposium on thermal insulating materials was held, with the general purpose of pointing out important problems in the field of standardisation and research.

In a Paper on "Factors Influencing the Thermal Conductivity of Non-Metallic Materials," MR. J. B. AUSTIN gives a comprehensive survey and summary of fundamental problems in the physics of heat flow and the physics and chemistry of insulating materials. In connection with chemical composition, he stated that those compounds which have a simple molecular structure and which crystallise in a lattice of high symmetry (as, for example, magnesia, which crystallises in the isometric system) are better conductors than more complex compounds such as magnesium silicate. Among the simpler compounds, the best conductors are those whose component atoms have most nearly the same weight and the same electronic structure. Physical constitution has a larger influence on thermal conductivity than any other single variable. This is well illustrated by magnesia, which in the crystalline pore-free form is one of the best conductors among the refractory oxides, but in the form of powder ("precipitated magnesia") is one of the best refractory insulators. The effectiveness of the powder as an insulator is due to the presence of a film of air around each particle and is not a property of the magnesia itself; nevertheless, the difference in the conductivity of the two materials, which is of the order of a hundredfold, is a striking illustration of the influence of texture.

A Paper by H. H. Rinehart outlined the viewpoint of the producer on various problems, and the author concluded that it appears desirable to establish standard methods of test for thermal insulations covering the following, some of which apply to plastic insulations and some to preformed: (1) mixing procedure; (2) preparation of sample for tests; (3) dry moulded density, expressed as such or as "dry coverage in board feet per 100 lbs. of dry cement"; (4) temperature resistance. Thought and study are necessary both as to the desirability of standards and methods to be employed regarding the following: (1) consistency; (2) adhesion to steel; (3) cracking and curling; (4) absorption; (5) corrosiveness; (6) hardness; (7) flexural strength; (8) abrasion resistance; (9) toughness; (10) compressive strength, and (11) durability. It appears unnecessary to establish standards on the properties of loose density, screen analysis, shear strength, tensile strength, porosity and permeability.

Reviewing the subject from the consumer's angle, E. T. Cope and W. F. Kinney indicated that certain characteristics are more important than others. Under the heading of "Preformed Material" the characteristics were listed in the following order of importance:—(1) Resistance to deterioration at working temperature; (2) resistance to breakage; (3) thermal conductivity; (4) ease of handling, and (5) advantageous disposal of second-hand material. In the case of unformed material the grouping was: (1) Resistance to deterioration at working temperature; (2) absence of caustic alkalinity; (3) trowellability; (4) air-drying shrinkage, and (5) thermal conductivity.

The final Paper, representing a contribution from the American Society of Heating and Ventilating Engineers, prepared by the Director, F. C. Houghten, and two assistants, dealt with unusual aspects of heat flow.

Company Meetings

Millom & Askam Hematite Iron Company, Limited

The annual meeting of the Millom & Askam Hematite Iron Company, Limited, was held in London last week. SIR ANDREW LEWIS (chairman), having reviewed the accounts, which showed a profit for the year ended December 31 last of £115,214, said that the reconstruction work at the Millom furnace plant was continued throughout the year. The No. 1 furnace had been rebuilt, and Nos. 1, 2, 3 and 5 stoves were being repaired and remodelled so that they would be able to cope efficiently with the increased capacity of this furnace. Nos. 2 and 3 furnaces worked very satisfactorily in 1938, but No. 3 furnace was damped down on August 31 last, leaving only the No. 2 furnace in blast. The furnaces gave every cause for satisfaction and fully lived up to their expectations for their economical working. No. 2 furnace output improved to such an extent that in one month they had an output of 11,971 tons, which was a record for a hand-charged furnace of this type. The ore-sintering plant worked continuously throughout the year with excellent results, and the new dust-collecting plant was put into operation in June last and had proved a big aid to efficiency. Their ore-sintering plant had now proved its value from every point of view; it had more than met their expectations with regard to the quantity and quality of the sinter produced and had materially assisted in lowering the coke consumption at the furnaces. The only difficulty they experienced in achieving record outputs from their furnaces was that of coping with the casts of pig-iron in the pig beds, and this, combined with the fact that there was an increasing demand from pig-iron consumers for machine-cast pig-iron instead of sand-cast iron, had decided the directors to instal a modern pig-casting machine. They had made arrangements for the erection of a double-strand pig-casting machine of the most suitable type for a commercial plant such as Millom and one capable of coping with the full output at the furnaces. Preparations for its erection were now going forward. The erection of this pig-casting machine would not only enable them to meet the market with regard to machine-cast pigs, but would also place them in a much better position to deal with the demand for iron when trade increased.

International Nickel Company of Canada, Limited

The annual meeting of the International Nickel Company of Canada, Limited, was held in Toronto on Tuesday, March 28. MR. ROBERT C. STANLEY (chairman and president) pointed out that the net profit in 1938 of $32,399,470.23 was $17,900,153.58 less than the figure of $50,299,623.81 reported for 1937. The decrease in earnings was due to a lower volume of nickel sales, to the lower prices realised for copper and platinum metals, and to the weakening of sterling in terms of the dollar. The recession which developed in United States trade during the autumn of 1937 continued until the summer of 1938, and the company's nickel business in that country during this period was only 38 per cent. of the business for the like months of the previous year. However, there was steady improvement during the last six months of 1938. On the other hand, overseas nickel business, which seldom fluctuated to the extent of United States business, was comparatively steady, so that for the entire year under review the company's total sales of nickel attained a level equal to 79 per cent. of that for 1937. Their selling prices remained unchanged.

Gibbons (Dudley), Limited

MR. C. S. BENNETT presided at the annual meeting of Gibbons (Dudley), Limited, held at Birmingham last week. In moving the adoption of the report, he referred to the present state of international affairs. He said that during the past year there had been some critical experiences, but at one time there was a prospect of a satisfactory result. In the last few days, however, hopes had become deferred. It had therefore become essential for the company to conserve resources as far as possible. No one could say at present what the Chancellor of the Exchequer was likely to impose in the way of further taxation. He had hinted that there would be no increase in income-tax, but there had been no mention of addition to the National Defence Contribution. It could only be hoped that there would soon be something definite from him. This year the company had to meet the cost of holidays with pay, an item he did not begrudge, but which would amount to a considerable sum.

Of interest to Pig Iron Users

THE STANTON METALLURGICAL SERVICE

The Stanton Company believe that a mutual policy of collaboration in more scientific and better methods of manufacture, can do much to widen the field for cast-iron products.

The Stanton Company therefore offer to all those engaged in the Iron Foundry Trades the free advisory service of specialists in metallurgical practice and technique.

This service takes the form of analyses and tests by the Company's Research Department on castings submitted to them, and constructive suggestions if the desired results are not being attained.

Where there are difficulties in works practice which can best be investigated on the spot, the service provides for a personal visit from a Stanton metallurgical expert, who will collaborate with the foundry staff.

THE STANTON IRONWORKS COMPANY LIMITED
Near NOTTINGHAM

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

The Week's News in Brief

Trade Talk

The Grey Iron Founders' Society (U.S.A.) will hold its annual meeting in Cincinnati, Ohio, on May 15.

S. P. Austin & Sons, Limited, Sunderland, have obtained an order to build a collier of 4,000 tons deadweight.

The British Industries Fair will be held next year in London and Birmingham from February 19 to March 1.

The export price of aluminium ingots has been raised by £5 to £95 per metric ton. The home price is £94 per long ton.

In the last few weeks 179,000 steel shelters have been issued free by the Government, affording protection to nearly 895,000 people in 51 towns.

One hundred years ago, on April 2, 1839, William Dixon, the Glasgow ironmaster, blew in the first blast furnace at his Govan Iron Works, Glasgow.

The Poldi Iron & Steel Works, Czecho-Slovakia, have presented a satisfactory report for 1938, and are to pay a dividend of 50 cr. per share, as in 1937.

Mr. William Ernest Horsman, ironfounder, lately carrying on business at Eveline Road, Mitcham, Surrey, is paying a second and final dividend of 7¾d. in the £.

Seven men were burnt last week, one fatally, by molten steel in the works of Edgar Allen & Company, Limited, Sheffield, when a ladle fell and capsized owing to the breaking of the suspension hook.

Mr. R. C. Shepherd, foundry manager of Ruston & Hornsby, Limited, Lincoln, gave an address on the "Production of Diesel Engine Castings," at the monthly meeting of the Nottingham Institute of Production Engineers.

Meehanite Metal Corporation, of Pittsburgh, Pa., has granted the right to manufacture Meehanite Metal to the Lowes Foundry Company, of Lower Hutt, New Zealand, and Booth-MacDonald & Company, Limited, of Christ-Church, Australia.

Following the announcement of the Government's plans to aid the shipping industry, Sunderland shipyards last week announced the receipt of a number of orders. W. Doxford & Sons have received sufficient orders to keep the yard busy for twelve months and to reopen their West yard.

International Combustion, Limited, held their fifth annual ball at the Assembly Rooms, Derby. Among those present were the Mayor and Mayoress of Derby (Alderman and Mrs. D. S. Bulter), Mr. F. G. Penny (director and works general manager), and Mr. F. Gudgeon (works manager).

Thos. W. Ward, Limited, Sheffield, have taken a controlling influence in Thomas Smith & Sons (Rodley), Limited, Rodley, crane and excavator manufacturers. The following gentlemen have been added to the board: Mr. Joseph Ward, J.P. (chairman), Mr. Frank R. Stagg, Mr. James Bussey, and Mr. C. A. Lee.

Sir Arthur Sutherland, on behalf of his firm, B. J. Sutherland & Company, Limited, Newcastle-upon-Tyne, has placed orders with Joseph L. Thompson & Sons, Limited, Sunderland, for two steamers, each of 9,000 tons deadweight. The engines will be supplied by the North Eastern Marine Engineering Company (1938), Limited, Wallsend.

New Items in Income-Tax Assessments

(*Concluded from page* 284.)

law. Thus, capital expenditure on A.R.P. for tax purposes (although compulsory) is not deductible, and in this connection it might be useful to point out that, as shown above, although expenditure on certain emergency fittings for A.R.P. is deductible, expenditure which results in the physical alteration of, or in the incorporation of additions to, the structure of the premises is considered as capital expenditure and will not be allowed. In relation to the compulsory provision of shelters, however, it might be useful to note that the Government will make a grant towards such expenditure, being an amount equal to the standard rate of income tax on the capital expenditure.

Among new shipbuilding contracts placed with Scottish yards is an order for a cargo motorship of about 8,500 tons received by Barclay Curle & Company, Limited, from the British India Steam Navigation Company, Limited. Burntisland Shipbuilding Company, Limited, is to build a motor cargo ship of 9,000 tons dw. for Nomikos (London), Limited. Propelling machinery will be supplied by Wm. Doxford & Sons, Limited, Sunderland. Two cargo motor vessels for the Nourse Line will be built by Charles Connell & Company, Limited, Scotstoun, and in this case the propelling machinery will be built by Barclay Curle & Company, Limited.

Personal

Mr. O. J. Heathcote, chief wages clerk at the Stanton Ironworks Company, Limited, has retired after 57 years' service.

Mr. Jonathan Bridge, chairman of the engineering firm of David Bridge & Company, Limited, Castleton, Rochdale, has been elected to the Commission of the Peace for the Borough of Rochdale.

Mr. Alfred Davis, who for a number of years has been chief superintendent engineer of Elder Dempster Lines, Limited, is joining the board of directors of John G. Kincaid & Company, Limited, marine engineers, of Greenock, and will carry out duties of general manager.

Mr. Alan E. L. Chorlton, M.P. for Bury since 1935, will not seek re-election in the constituency. His decision has been prompted by ill-health. Mr. Chorlton is chairman of Edward Wood & Company, Limited, Lancashire Dynamo & Crypto, Limited, and other engineering companies.

Mr. J. S. Fraser, who has been manager of the Corby iron and steel works of Stewarts and Lloyds, Limited, since developments began there in 1933, relinquished his appointment at the end of last month. Mr. Fraser is being transferred to the London offices of the company. Mr. Fraser has had complete control of the Corby iron and steel works, and mines, where his long experience in the iron and steel industry has stood him in good stead. Mr. J. Mitchell will become local director in charge of the steelworks following Mr. Fraser's departure. The new manager of the works at Corby (including the quarries), under Mr. Mitchell, will be Mr. W. C. Bell, who has been joint general manager of the research and technical development department of the company.

Wills

Bolton, E. J., director of Thomas Bolton & Sons, Limited, smelters and refiners, of Widnes £33,444

Neville, T. H., of Walsall, senior partner in T. C. Neville & Sons, engineers and ironfounders £12,317

Kennedy, Sir Alexander M., of Gosforth, Northumberland, late chairman of the Fairfield Shipbuilding & Engineering Company, Limited, Govan, Glasgow £84,859

Mond, E. S., chairman of Ashmore, Benson, Pease & Company, Limited, engineers, Stockton-on-Tees, and of the South Staffordshire Mond Gas Company £158,897

Whitehead, Albert, deputy chairman of the Staveley Coal & Iron Company, Limited, and a director of Cammell Laird & Company, Limited, Birkenhead, and other companies £232,940

Obituary

Mr. A. R. Crook, of Sheffield, died recently at the age of 47. Mr. Crook was for many years associated with George Cooper & Sons, Effingham Nut and Bolt Works, Sheffield, and was later head of the commercial staff of Thos. W. Ward, Limited.

The death is reported of Mr. F. Hodek, Sen., of the General Porcelain Enamelling & Manufacturing Company, of Chicago. He was father of Mr. F. Hodek, Jun., President of the Porcelain Enamel Institute, who accompanied members of the Institute of Vitreous Enamellers during the tour in the United States last autumn.

Company Reports

Manganese Bronze & Brass Company, Limited.—Net profit for 1938, £83,187; final dividend of 50 per cent., making 75 per cent.

Vulcan Foundry, Limited.—Net profit for the 18 months ended December 31 last, £66,239; brought in, £9,255; dividend of 5 per cent. on the ordinary shares, £42.255; carried forward, £26,439.

Worthington-Simpson, Limited.—Net profit for 1938, £39,443; brought in, £15,599; tax, £13,187; dividend of 7 per cent. on the ordinary capital for the year; to general reserve, £5,000; carried forward, £16,319.

Robey & Company, Limited.—Profit for 1938, £16,614; balance after providing for interest, depreciation and other charges, £5,834; brought in, £1,817; sinking fund appropriation, £258; interest on income debenture stock, £2,271; carried forward, £5,122.

British Oxygen Company, Limited.—Net profit for 1938, after depreciation, tax, N.D.C., and contributions to staff and works pension funds, £508,059; brought in, £44,385; to general reserve, £62,160; to reserve against buildings, plant and cylinders, £50,000; final dividend of 10 per cent., making 17 per cent.; carried forward, £48,007.

English Steel Corporation, Limited.—Trading profit for 1938, £1,445,796; brought in, £73,104; tax and N.D.C., £500,216; depreciation, £200,000; debenture interest, £66,029; debenture sinking fund, £14,793; preferred ordinary dividend, £113,116; dividend on the deferred shares of 20 per cent., £226,224; to reserve, £200,000; carried forward, £75,798.

Vickers-Armstrongs, Limited.—Profit for 1938, after providing for contingencies, £2,754,679; brought in, £120,260; tax and N.D.C., £1,074,884; depreciation, £575,000; 7 per cent. "A" preference dividend, £309,567; dividends for five years and two months to September 30, 1934, on the 6 per cent. "B" preference shares, £786,625; carried forward, £128,863.

Vickers, Limited.—Full report shows profit for 1938, £1,975,608; income tax, debenture interest, etc., £576,756; to contingencies reserve, £100,000; to reserve, £350,000; preference dividends, £418,190; interim dividend of 4 per cent. on the ordinary stock, £178,574; brought in, £237,534; final dividend of 6 per cent., making 10 per cent., £267,862; carried forward, £321,760.

Contracts Open

Cambridge, April 18.—Spun-iron pipes and special castings (Class C.), for the South Cambridgeshire Rural District Council. The Clerk, County Hall, Hobson Street, Cambridge.

Dewsbury, April 15.—Cast-iron pipes, etc., for 12 months, for the Town Council. Mr. G. E. V. Boldry, water engineer, 10, Church Street, Dewsbury.

Manchester, April 11.—Supply and erection of four 1-ton jib cranes, for the Town Council. The General Manager, Corporation Transport Department, 55, Piccadilly, Manchester.

Manchester, April 17.—Three-ton (at 12-ft. radius) mobile crane, operated by petrol or heavy-oil engine, for the Town Council. The Committee Secretary, Waterworks Offices, Town Hall, Manchester, 2.

Wakefield, April 12.—200 yds. of 15-in. spigot and socket spun cast-iron pipes, lined centrifugally with concrete, also about 1½ tons of flanged specials and 2 tons of spigot and socket specials, for the Town Council. The Waterworks Engineer, Town Hall, Wakefield.

New Companies

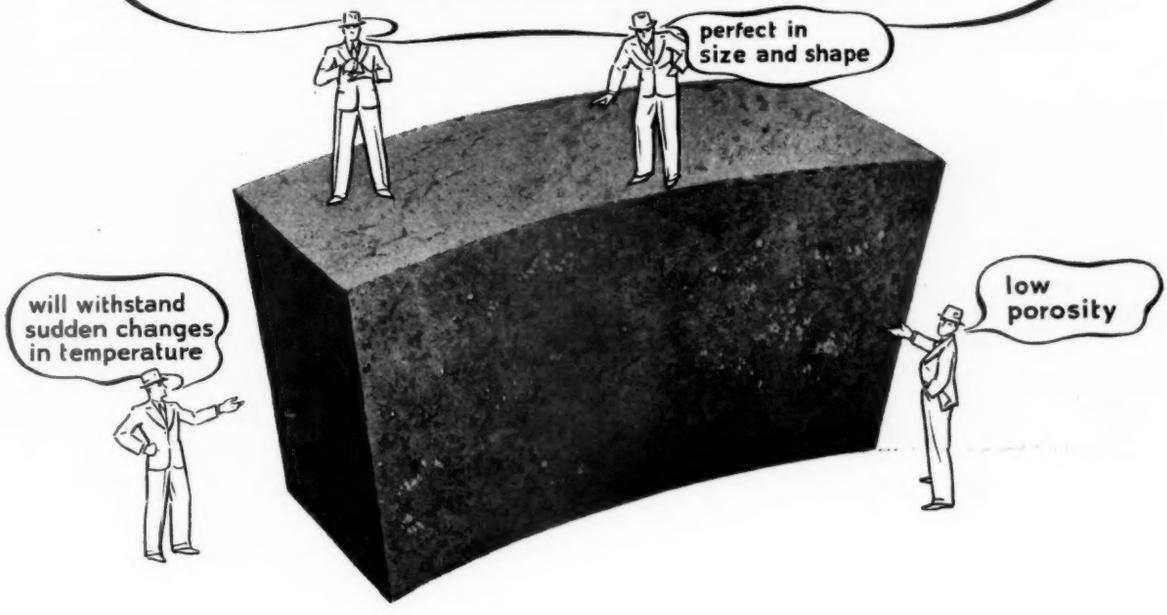
(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Loded Iron, Limited.—Capital, £100. Subscriber: A. J. Fossey, 160, Rushden Gardens, Ilford, Essex.

Whitefield Foundry, Limited, Lord Street, Whitefield, Manchester.—Capital, £1,000. Directors: H. Spring and W. Burrows.

Salmon Anti-Friction Metal Company, Limited.—Capital, £2,000. Subscriber: C. H. Harmer, 11, Birchin Lane, London, E.C.3.

Reliability—is certainly the word to describe these bricks



The firebricks supplied by General Refractories Ltd. can be relied upon to give complete satisfaction. Brands of firebricks are manufactured to meet every requirement and the utmost care is taken in the production of both standard sizes and special shapes, so that they are always of the same high quality. Due to the fact that our works are situated at points throughout the country, it is often found that delivery can be given from a works close to your own vicinity and, therefore, railway rates are reduced to a minimum—a very important consideration. Our Technical Staff is at your service for advice on any problem regarding the selection of the correct grade of firebricks to meet your exact needs.

Write NOW for full particulars

GENERAL REFRACTORIES LIMITED,

GENEFAX HOUSE, SHEFFIELD, 10.

Telephone: Sheffield 31113 (6 lines) *Telegrams:* "Genefax Sheffield."

Raw Material Markets

While other sections of the iron and steel markets are much more active than they were earlier in the year, there has been little improvement in the demand for foundry iron and business is still at a low level. Government orders in connection with defence projects continue to be placed and firms engaged on this work will be fully employed for a considerable time. In view of the shortage of civil work and orders from abroad, rearmament contracts are very welcome.

Pig-Iron

MIDDLESBROUGH.—Foundry-iron producers in this area have favourably received the Government's proposals to render assistance to the shipping industry, and it is hoped that shipbuilding contracts in this district will show a marked expansion in the near future. Orders for foundry iron continue to be disappointing and if the shipyards become busier there should be an increase in the call for supplies of iron. The scarcity of scrap has brought more orders for basic iron and by Easter there will be 25 blast furnaces producing this iron in the Cleveland area, as compared with 19 at the beginning of the year. Local steelworks are absorbing the entire make of basic iron.

There is little change in the hematite market; new business is better than it was a few months ago, but most consumers are well covered by contracts entered into last year. Consumption continues to expand and it is anticipated that there will be more business about following the end of the financial year, which for many companies was March 31. The demand for hematite from the Continent is still unsatisfactory and only small tonnages are being despatched abroad.

LANCASHIRE.—Although the current paucity of new orders for foundry iron may partly be attributed to the unsettled condition of the international outlook, consumers are not at all well employed in many instances and consumption is not at the level which might be expected. Especially does this apply to the light-castings foundries, which are working short time, as also are some of the jobbing foundries. Speciality engineers are mostly well employed, while other consumers, such as machine-tool makers and heavy electrical engineering concerns, have well-filled order-books. It is anticipated that the difficulty now being experienced in obtaining supplies of scrap will favourably affect the demand for foundry iron. Trade in hematite is largely confined to contract deliveries; specifications against existing contracts are on a much improved scale, but new business as yet has not shown much increase.

MIDLANDS.—Heavy engineering concerns and motor and machine-tool foundries continue to be busy and are taking up supplies of low-phosphorus iron and hematite in heavy tonnages. These concerns also use high-phosphorus iron to some extent, but the demand for this grade of iron from these consuming trades and others is still very poor. New business is restricted to small parcels for early delivery and very little forward contracting has been done. Until stocks at the consuming plants have been worked off, or, at least, considerably reduced, there will be little improvement in this section of the trade. For delivery to Birmingham and Black Country stations, Derbyshire No. 3 foundry iron is quoted at 101s., with Northamptonshire No. 3 at 98s. 6d., both subject to 5s. per ton rebate. Low-phosphorus iron is quoted at from £5 5s. to £6, delivered, although it is understood that some business has recently been transacted at a price somewhat below £5 5s.

SCOTLAND.—The tone of the pig-iron market in this area continues to be disappointing and new business is difficult to obtain. Ten blast furnaces are in operation, but the current output is more than sufficient to meet the demand, and stocks are accumulating at the makers' depôts. It is hoped that there will shortly be increased activity among light-castings founders, but, as yet, there has been little expansion of business and short time is general. The shipbuilding concerns, too, are badly situated for work, but it is anticipated that there will be increased activity as a result of the Government's proposals to subsidise new shipbuilding orders. No. 3 foundry iron is quoted at 105s. 6d., and No. 1 at 108s., f.o.t. furnaces. The demand for steel-making iron continues to expand. Hematite mixed numbers are quoted at 120s. 6d. and basic iron at 92s. 6d., both less 5s. rebate and delivered works.

Coke

The demand for foundry coke continues to be well maintained, and business is on a good scale. Consumers are generally in possession of quite substantial stocks, but there is no sign of weakness in the market. For delivery to Birmingham and district up to the end of the first half of the year, the minimum quotation for Durham and Welsh coke is 50s. 6d. per ton.

Steel

Business in nearly all sections of the steel market is satisfactory, and is likely to continue so while the present rate of rearmament work is maintained. Orders for structural material, which until recently were quiet, have still further improved and heavy tonnages have been specified under orders placed during the past week or two. Heavy sections, too, are now in much better request. Sheet mills are well employed dealing with orders under defence work, but civil business is not satisfactory. In fact, it must be admitted that it is the rearmament programme that is keeping the steel industry employed at its present level.

Scrap

It is understood that a delegation has already left for the United States in order to arrange the importation into this country of supplies of scrap steel. Home-produced material is becoming scarcer in all districts and is quite inadequate to meet the expanding demand. Merchants are compelled to ration their deliveries and quotations for some descriptions have been increased.

Metals

The non-ferrous metal markets continue to show commendable strength in view of the delicate international situation. The Government's guarantees to Poland have done much to clarify British foreign policy in the eyes of the layman and more settled conditions are expected in the commercial world.

Copper.—Armament and some other concerns continue to take up quite substantial tonnages of this metal under contracts, but there is still little new business being transacted, owing to the uncertainty of the forward position. Japan, and to a lesser extent the U.S.S.R., are still in the market, but trade in the United States remains rather dull. In fact, domestic sales of copper in America during the first half of March totalled only about 13,400 short tons. The Chilean Senate has approved the proposals for an additional tax of 10 per cent. on copper companies' profits.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £43 3s. 9d. to £43 6s. 3d.; Friday, £43 3s. 9d. to £43 5s.; Monday, £43 6s. 3d. to £43 7s. 6d.; Tuesday, £42 16s. 3d. to £42 18s. 9d.

Three Months.—Thursday, £43 8s. 9d. to £43 10s.; Friday, £43 8s. 9d. to £43 10s.; Monday, £43 11s. 3d. to £43 12s. 6d.; Tuesday, £43 2s. 6d. to £43 5s

Tin.—There is little life in this market at the present time and consumers are still buying on a hand-to-mouth basis. American buying continues to be at a very low ebb, but it is not thought likely that this will continue to be so for much longer, although there are few signs as yet of any change.

The tin statistics for March compiled by Mr. W. H. Gartsen (Henry Rogers, Sons & Company) reveal that the total visible supply on March 31 totalled 25,314 tons, against 24,489 tons on February 28. The carry-over in the Straits Settlements was 5,680 tons on March 31 (7,547 tons on February 28), while the corresponding figures for the carry-over at the Arnhem (Holland) smelter were 1,735 tons and 1,524 tons.

Official quotations were as follow :—

Cash.—Thursday, £215 15s. to £216; Friday, £215 to £215 5s.; Monday, £216 5s. to £216 10s.; Tuesday, £215 to £215 5s.

Three Months.—Thursday, £214 10s. to £214 15s.; Friday, £213 15s. to £214; Monday, £215 to £215 5s. ; Tuesday, £213 15s. to £214.

Spelter.—No announcement has yet been made in connection with the application for a higher import duty on zinc; rumours have it that a revised duty will operate as from May 1, but there is no official support for this attitude. Meanwhile, consumers are placing orders for only their immediate requirements and the market is dull, although the undertone is remarkably sound.

Daily market prices :—

Ordinary.—Thursday, £13 10s.; Friday, £13 8s. 9d.; Monday, £13 6s. 3d.; Tuesday, £13 1s. 3d.

Lead.—The consumption of this metal is believed to be fairly good, but considerable tonnages are being used by the armament concerns, without whose support the market would be badly situated. In the United States, there has been more activity and working-up industries are operating at a satisfactory rate in most cases. World lead production totalled 132,047 metric tons in January, compared with 128,658 tons in December, according to figures compiled by the Metallgesellschaft. United States output increased substantially from 28,112 tons to 34,744 tons, but Mexican output remained low in reflection of the strike on the Asarco's smelter at Monterrey. Changes in the output of other countries were small.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 10s.; Friday, £14 6s. 3d.; Monday, £14 6s. 3d.; Tuesday, £14 3s. 9d.

Scrap.—Quite a good turnover has been made in this section, despite the unsettled atmosphere in which business has been done. Inquiries from the Continent are increasing, especially from Germany.

Approximate selling prices for old metal:—New aluminium cuttings, £70; rolled, £57; cast, £32 to £33; foil, £80. Copper, £39 to £44; braziery, £36. Brass (clean), £20 to £24. Zinc, £10. Lead, £13 15s. Gunmetal, £38 to £39.

Foundry Work in Dentistry

(*Concluded from page 284.*)

the profession was known as walroth. Not only had he to carve the teeth but also the undersurface of the palate, which had in many cases to fit tender gums. When first made, these dentures looked beautiful, but after six to 12 months became highly discoloured, because ivory was porous; therefore, the patient would be possibly digesting on one day what he had eaten the previous day! Teeth had been made of gold and silver, the latter not being suitable owing to a deposit of silver sulphide. To-day teeth were made from a high-quality porcelain, the ingredients being China clay, fluorspar and, in some cases, silica. In the front or anterior teeth, two pins were embedded in the posterior part of the tooth, which gave anchorage to the vulcanite, or maybe soldered on to a metal backing in the case of metal plates. These teeth were chiefly made in America and Germany; but it was significant that an English dentist had a prior patent which was never exploited before the American ones. Notwithstanding the fact that more teeth were made in America than in any other part of the world, teeth were made in this country, and there could be no possible doubt that the English porcelain tooth was the finest in the world.

DR. C. J. DADSWELL seconded the vote of thanks, which was carried with acclamation.

Dr. Froggatt showed some beautiful examples of castings in gold and silver, principally castings in silver, of geranium leaves, and also cast jewellery, of which the patterns were double white May blossom. In passing, he mentioned that the patterns for the double white May blossom had been obtained from a tree in Endcliffe Woods, Sheffield, and although he had travelled extensively, he had never yet found a tree of double white May blossom in any other part of the country.

Metro-Vick "Girl" Calendar

We have received from Metropolitan Vickers Electrical Company, Limited, of Trafford Park, Manchester, the 1939 edition of their well-known "Girl" calendar. It is one of the most attractive in the series.